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PLANTS FROM WHICH OILS ARE OBTAINED

1, Flax. 2, Olive. 3, Cotton. 4, Castor Oil. 5, Lavender.

THE GREEN EARTH

BY

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PREFACE

This is a book about plants. It explains some of their ways and functions, how they breathe, feed and multiply. And a few of the more important individuals amongst them are described, with some account of their usefulness to man and beast. It is hoped that this introduction to plant life may lead to a realization of its wonder and beauty and to a desire for a wider knowledge of the underlying plan.

It is necessary to state that the botanical explanations given are intentionally sketchy. This is not a botany book, but a rambling excursion along verdant paths. If the reader is brought at the finish to a wish for further exploration, so much the better.

I have included some short descriptions of the more common British wild flowers, for the benefit of those fellow-ramblers who like to know the names of things.

CYRIL HALL.

CONTENTS

Chap.		Page
I.	A Bit of Bother with the Catkins	11
II.	A Chat about Pollination	16
III.	The Green World	24
IV.	Some Sorts of Vegetables	33
V.	How Plants Grow	48
VI.	Leaves and their Uses	61
VII.	Pulling Flowers to Pieces	73
VIII.	Something about Fruits and Seeds	87
IX.	Among the Trees	104
X.	The Soil	115
XI.	Blades of Grass	125
XII.	Vegetable Oils and their Uses	143
XIII.	Under the Bark	152
XIV.	Plant Protection	158
XV.	Parasites and Epiphytes	159
XVI.	Insectivorous Plants	175
XVII.	Plant Relationships	184
XVIII.	Plant Life of the British Isles	192
XIX.	Flowers of Meadows and Fields	200
XX.	Flowers of Hedges and Ditches	211
XXI.	Flowers of the Cornfield	228
XXII.	On the Chalk Downs	236
XXIII.	Flowers of the Waterside	247

Chap.		Page
XXIV.	Flowers of the Heath	253
XXV.	Flowers of the Woodlands	261
XXVI.	Flowers of the Seashore	266
XXVII.	Algæ and Fungi	272
	Index	281

LIST OF PLATES

Facing Page

PLANTS FROM WHICH OILS ARE OBTAINED (*coloured*) *Frontispiece*
1, Flax. 2, Olive. 3, Cotton. 4, Castor Oil. 5, Lavender.

LEAVES, FLOWERS AND FRUITS OF SOME CONIFERS (*coloured*) - 33
1, Corsican Pine. 2, Wellingtonia. 3, Scotch Fir. 4, Larch. 5, Cedar. 6, Douglas Fir. 7, Yew. 8, Cypress. 9, Stone Pine. 10, Spruce Fir. 11, Cluster Pine.

LEAVES, FLOWERS AND FRUIT OF SOME BRITISH TREES - - 65
1, Hazel. 2, Lime. 3, Sycamore. 4, Abele or White Poplar. 5, Holly. 6, Beech. 7, Birch. 8, Ash. 9, Box. 10, Oak. 11, Common Elm. 12, Wych Elm. 13, Western Plane.

A BANANA TREE IN FLOWER - - - - - - - - 81

COTTON POD WITH SEEDS - - - - - - - - - 96

CROSS-SECTION OF A WELLINGTONIA (*Sequoia gigantea*) - - 101

DRAWING OFF THE LATEX FROM RUBBER TREES - - - 108

LEAVES AND FLOWERS OF RUBBER TREE (*Hevea Braziliensis*) - 108

QUEEN OF THE NIGHT - - - - - - - - - - 161

THE LARGEST INFLORESCENCE IN THE WORLD - - - - 176

BRITISH WILD FLOWERS (*coloured*) - - - - - - - 193
Ragged Robin, Meadow Crane's Bill, Bird's Foot Trefoil, Devil's Bit Scabious, Yellow Rattle, Lady's Smock, Long-rooted Cat's Ear, Self-heal, Meadow-sweet.

BRITISH WILD FLOWERS (*coloured*) - - - - - - - 209
Corn Cockle, Tufted Vetch, Teasel, Scarlet Pimpernel, Blackthorn, Herb Robert, Berries and section of spathe of Lords and Ladies, Traveller's Joy, Black Bryony, Lord and Ladies.

Facing Page

British Wild Flowers (*coloured*) - - - - - - - 222
Bittersweet, Deadly Nightshade, Shepherd's Purse, Common or Marsh Mallow, Wood Anemone, Purple Dead Nettle, Henbane, Bugle, Wood Sorrel, Small Periwinkle, Wood Loosestrife, Tansy.

British Wild Flowers (*coloured*) - - - - - - - 241
Samphire, Thrift, Sundew, Fleabane, Purple Loosestrife, Valerian, Sea Holly, Great Hairy Willow Herb, Arrow Head, Marsh Marigold, Water Mint.

British Wild Flowers (*coloured*) - - - - - - - 256
Cross-leaved Heath, Crimson Heath, Ling, Eyebright, Harebell, Milkwort, Rest Harrow, Tormentil, Fragrant Orchis, Spotted Orchid, Sheep's Bit Scabious.

Seaweeds - - - - - - - - - - - 261
1, Broad Ulva. 2, Cornucopia. 3, Caulerpa Cactoides. 4, Acetabularia Mediterranea. 5, Bladder-locks. 6, Long-stalked Laminaria. 7, Sugared Laminaria. 8, Bladder Wrack. 9, Serrated Wrack. 10, Gulf-weed. 11, Thalassiophyllum Clathrus. 12, Forked Dictyota. 13, Medicinal Coralline. 14, Corallina rubens. 15, Delesseria Lyallii. 16, Nitophyllum Crosieri. 17, Membrane-leaved Phyllophora. 18, Peacock's tail Padina. 19, Banded Taonia.

Fungi, Mosses and Lichen - - - - - - - 268

THE GREEN EARTH

CHAPTER I

A Bit of Bother with the Catkins

Some young friends of mine took up plant study for rather an odd reason. They lived in the country, and it might be supposed that their interest in the vegetable world was awakened by watching the growing green things around them. You might think that they would want to know what was going on in the fields and woods outside their doors; that the secret ways of the trees and the hedges, the pulse of life beating in time with the seasons, were things they could not help being interested in. Not a bit of it: these young friends were on familiar terms with the birds and beasts, and they called the insects by their pet names, so to speak. But with trees and weeds and garden plants they had barely a nodding acquaintance. Vegetables left them cold.

And then, one day, these young people were driven to defend themselves. They were thrown a good deal into the society of town-bred friends who knew much more about the plants and the secrets of their ways. A friendly rivalry began. To know less about their own countryside than these townsfolk knew of it was a state of affairs not to be tolerated.

On a bleak day in late winter I came on my friends, a somewhat depressed trio, apparently searching the hedges. I asked what was wrong.

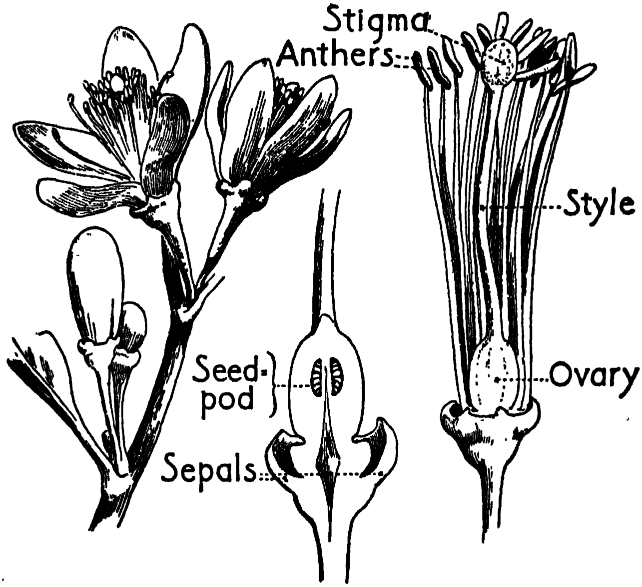
"It's young Bernard and Vera," George explained. (Bernard and Vera are their town friends). "They're frightfully keen on botany and they cough up any amount of long words. Latin names, you know. There's a big park where they go and mug up the names of trees from the labels stuck on them."

"That's all right," Bill conceded graciously, "if you like that sort of thing. But young Joan's let them pull her leg about hazel nuts—at least that's what it seems like. We're looking for catkins," he added.

Joan explained. "I think it's all rubbish, what Vera said. We were talking about catkins—there were some just showing in the hedge. She said the catkins don't grow into nuts, and I know they do, for we get lots of nuts out of the hedges every year. Everyone knows that the catkins are just flowers, and that flowers turn into seeds and that the cobnuts we gather in the autumn are the seeds of the hazel tree."

Later on, when we had exchanged the wind-bitten hedges for the fireside, I explained, as tactfully as I could, that what the town friend had said was not "all rubbish". I had to point out that there are always two parts to a flower; the male and the female part. The female part has a number of tiny eggs securely hidden in one or more egg-cases, or ovules. These ovules grow to be seeds. But before that can happen, they must be fertilized by the male part of the flower. The male part consists of *stamens*—little stalks carrying a marvellous sort of dust——"

("Pollen," Joan said; "it comes out in clouds if you touch the vase that I put some catkins in, a few days ago.")



The male and female parts of a flower (Orange blossom)

I told them that the cloud consists of great numbers of tiny grains, each one alive, and able, if it reaches the female part of the flower, to unite with an egg, or *ovum*, so that the ovule containing the egg can develop into a seed. The ovules are protected from harm in a chamber called the ovary, so that the making of a seed can go on unharmed by bad weather. The ovary is the lower part of the female organs of a flower; above it there is a hollow stalk (the style) which terminates in a sticky knob called the stigma. Fertilization takes place in this way: when a pollen grain gets caught on the sticky hairs of the stigma, it absorbs moisture and swells and bursts its skin. Then it sends out a thread-like tube which worms its way down the style until it reaches the ovule, which it enters. Finally, the

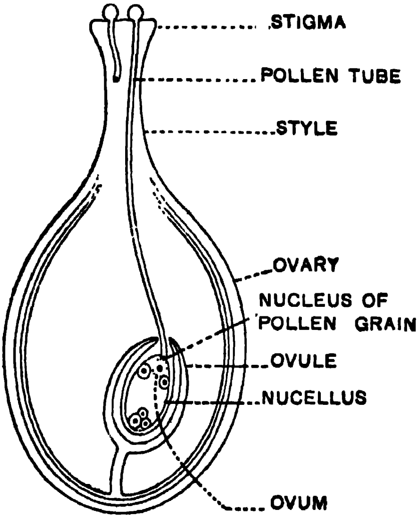


Diagram showing how the pollen brings about the fertilization of the ovule

living contents of the pollen grain pass down the tube and unite with the egg-cells in the ovule.

"That is what happens in all flowering plants, and you may well wonder at the miracle by which the germ of life is handed on from generation to generation. Some day we will examine the marvel of fertilization more closely and learn to know just how it is brought about. All I am going to tell you now is that in nearly all flowering plants the separate organs of the two sexes—the pollen-bearing stamens of the male and the stigma leading to the ovary or egg-chamber of the female—are arranged together as parts of the *same* flower. But there are just a few plants in which the male and female organs are not united, but exist as separate and quite distinct flowers.[1] The hazel is a plant of this kind. Vera is right. She, the town girl, knows more about the life of the hedges than you do, who pass them every day."

I wanted this to sink in. I wanted the "country cousins" to see that it was up to them to make the most of their opportunities. Joan looked sadly perturbed.

"But I've picked the nuts off those very bushes, often and often," she protested. "Surely the nuts are the hazel seeds, and the seeds must come from the flowers?"

[1] Flowers of this type are said to be unisexual.

" So they are, and so they do. But they do not come from the pretty catkins you bring into the house soon after the new year. Those are the male, or pollen-bearing flowers, consisting only of stamens. Such flowers can never turn into seeds, because, as Vera knows, only the female flower organs can make the fruit—in this case a nut—which holds the seed. You ought to have your eyes seen to, Joan, for there must be something wrong with your sight. You walk past those nut bushes hundreds of times in a year, yet you have never noticed that the catkins soon wither and fall off."

" Well, Joan's no worse than we are," said George. " I suppose we're all pretty slow in the uptake. You see, it's this way. The trees are just there—always—and that's why we don't notice them much. But the birds come and go, and we have to keep watching or we shouldn't see them. We're all keen on birds."

" I dare say we should get keen on trees and plants if we knew anything about them," Bill hazarded. " At least, we *might*," he added guardedly.

" Not with those awful names, thanks," George said. " What was it young Bernard called the grass—monocotyledonous? Silly ass!"

" I don't know, though," said Joan meditatively. " It's rather a nice word. It would go to music."

" About these catkins, now," put in Bill. " It's pretty queer, when you come to think of it. For if the nuts don't grow from the catkins, they must grow from some other flower on the same tree."

That was Bill all over. It might be a long while before he saw something just in front of his nose, but having at last caught sight of it he would not be happy until he had found out all he could about it. In pensive mood he went off to feed the horses.

CHAPTER II

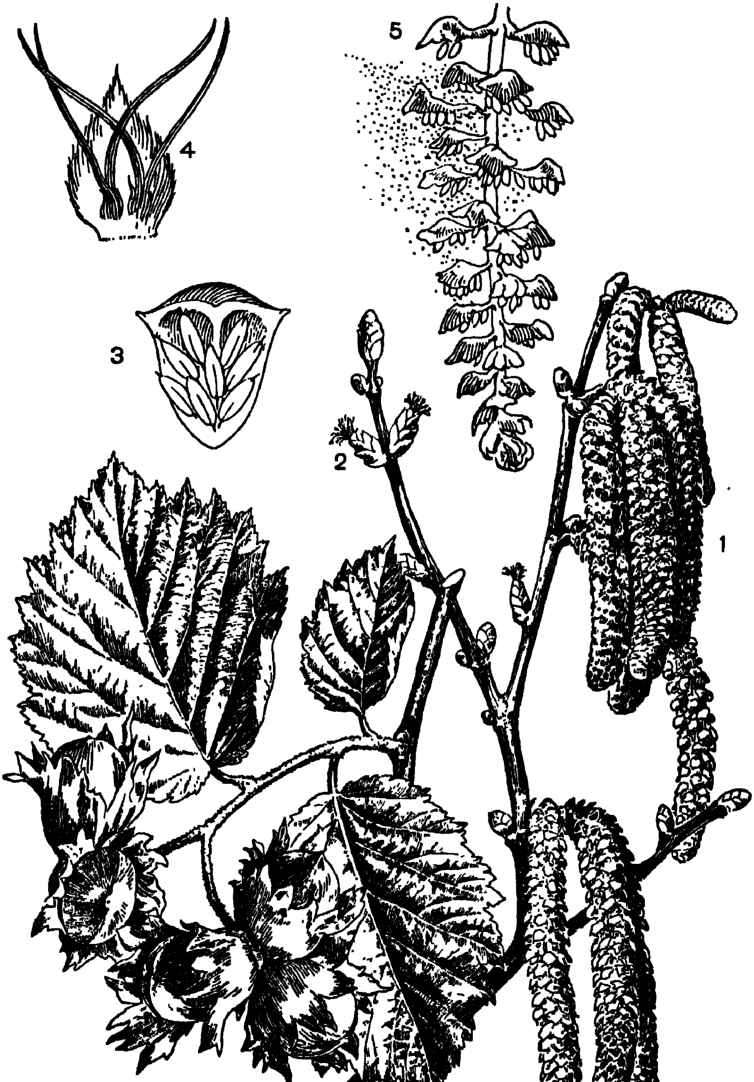
A Chat about Pollination

The problem of where the hazel nuts come from was not allowed to remain unsolved. Bill kept his nose down, like his old cocker spaniel, Kim. So when, a day or two later, a procession approached bearing hazel twigs I knew that Bill was still keen on the scent, and that he had succeeded in interesting his less inquisitive brother and sister.

"About these nuts," he began; "I believe I've found the flowers they come from."

"Are those tiny red things the female flowers?" asked Joan, waving a branch of hazel, and scattering clouds of yellow pollen from the male catkins as she came. "They don't look a bit like flowers. They are like tufts of wee red hairs growing out of a bud."

"Those unimportant looking red bristles are all that is visible of the female flowers. They are the stigmas ready to receive the pollen, so that the ovules in the ovaries, hidden under several layers of leaf-like scales, can grow into nuts. The hanging catkins that bear the pollen form a colony composed of a great number of individual *male* flowers, and in the same way these odd little red flowers also form a colony, composed only of *females*. You see how the male catkins all hang down, but the female all stick straight up, higher up the twig. Can anyone think of a tree in which *both* kinds of catkins grow erect?"



THE HAZEL

1, Male catkins. 2, Female flowers, which develop into hazel-nuts. 3, Underside of a single male flower showing the anthers. 4, Part of a female flower showing the forked stigmas. 5, Part of a ripe catkin discharging its pollen.

"The catkins of the pussy willow grow straight up," Joan said. "But I don't know whether they are male or female."

"Pussy Willow" is her name for the sallow or goat willow, which is also called "palm", and makes such a brave show in the hedges in early spring.

"The silky catkins you gather are the male flowers. The female catkins are about twice as big, but not nearly so pretty. Both sorts of willow catkins grow straight up. Do you remember what the seeds of the willow are like?"

"I do," said George. "There are some big willows round the cricket field and the ground gets covered with seeds." He checked himself. "No, dash it all—I believe they're poplars."

"That is much more likely. What are the flowers like?"

George shook his head. "I've never seen them."

"You mean, you've never noticed them. Well, what are the seeds like?"

"Oh, fluffy, woolly stuff that blows all over the place."

"The willow seeds are like that too," said Joan; "covered with white stuff like cotton wool. I thought we could use it to stuff a cushion, but it didn't act very well."

"Willows and poplars both have seeds that look somewhat alike. Those trees are related to each other; they stand in much the same relationship as cats and tigers. But even if you couldn't tell which was which just by looking at the bare branches and twigs in winter time, you can separate them quite easily as soon as the catkins appear in early spring, by noticing how the catkins grow. If the catkins stick straight up, like the goat willow or 'palm', then the tree is a willow; for the catkins of the poplars always hang down, like those of the hazel. There are two other very common trees with hanging catkins—the birch and

the alder—and these also are relations—almost as close relations as horses and donkeys."

Joan ticked off the trees on her fingers.

"Willow catkins stick up," she said. "Poplar, hazel, birch and alder hang down. Do all those trees have separate male and female flowers, or only the hazel?"

"Every catkin is a colony of flowers of one sex only. The two catkins, male and female, usually grow on the same tree, but not always. You would look in vain for female catkins on the trees from which you gather 'palm', for willow trees bear either male *or* female catkins, but never both on the same tree. There are many shrubs in the garden in which the sexes are separate, like the willow. There are male and female aucubas, and other shrubs with handsome berries which help to brighten the garden in winter; and unless we had a male plant of each sort as well as a female plant, we could not hope to have berries." [1]

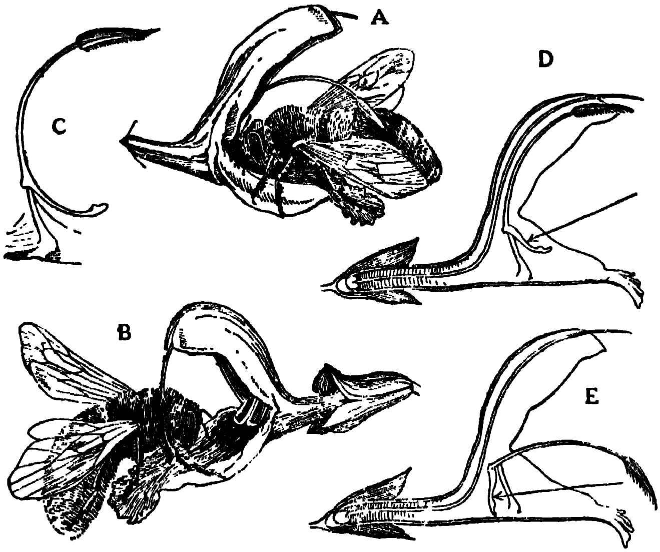
This set Bill thinking. "About this catkin business," he began. "What's the idea? I mean, why should these flowers be so different from most flowers?" He flicked the bunch of hazel with his finger, and the pollen came out like a puff of smoke. "I suppose it has something to do with this dust stuff, but I don't see what."

"How do most flowers get fertilized, Bill?"

The cautious Bill hesitated. He must have known the answer, but Joan got in first.

"By bees," she said. "I know that, because you are always so anxious in the spring, when the plum and pear blossom comes out. If it is too cold or wet for the bees to be working, you go round the fruit trees growing on the

[1] When the male and female flowers are borne separately on the same plant, the plant is called *monœcious* (mon-e-shus), which is Greek for *single dwelling*. Plants in which the sexes are borne on separate individuals, like the willow and aucuba, are *diœcious* (di-e-shus), meaning *double dwelling*.



How the bees pollinate a sage flower

A, A bee visiting a flower, the pollen-covered anther is striking the bee's back. B, The bee, carrying on its back pollen, is rubbing it off on to the deflexed stigma of another flower. C, A stamen on its rocking lever. D, A section through the flower. E, The same section, the lower arm of the lever is pushed backwards, and in consequence the pollen-covered anther at the top of the other arm is bent down. The bee pushes its head in the direction of the arrows.

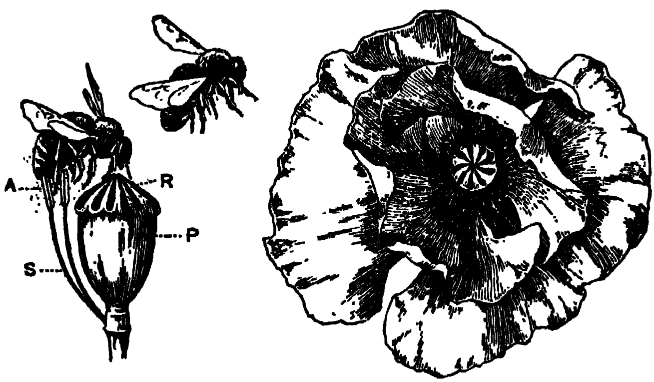
walls and dab the flowers with a tiny brush on a long stick."

"Oh, is *that* what you do it for?" said George. "I thought it was some stunt for killing insects."

"Bees, moths, insects of hundreds of different kinds are the true partners of the flowers. They help them to produce seeds by assisting in the process of fertilization. Pollen from the stamens of the flowers visited by an insect becomes attached to the hairs on its body, and is then carried to the next flower visited, where some of it is caught on the stigmas. Nearly all flowers are fertilized, or 'pollinated' in that way. And one of the great delights of plant study is found in understanding the marvellous ways in which the parts of the flowers are arranged so as to make sure

that they are successfully fertilized. Through a confusion of ideas we are apt to think that the beautiful colours and sweet scents of the flowers exist for our enjoyment. Yet we must not forget that it is never any part of a flower's business to please *us*. The form, the colour, the scent of a flower—all are designed with a single purpose—the purpose of reproducing its kind. A flower has no need to be attractive except to the creature that can assist it in fertilization. If it fails in that attraction, it will soon cease to exist.

" Bill quite properly connects cause and effect in the form of the hazel catkin—or any other catkin—and the huge quantities of pollen it bears. A few plants—very few—have flowers that are able to fertilize themselves without outside assistance; the great majority of flowers depend on the help of insects; but there are some that do without insect help, and rely instead on the agency of the wind for fertilization. The conifers, or cone-bearing trees, like the pines and firs, belong to this class; so do many of the grasses, and so do all the trees and shrubs in which the



Bees pollinating a poppy

On the right a bee is approaching an open flower. On the left is shown the ovary and two stamens, with a bee crawling across. A, Anthers covered with pollen. R, Stigmatic ridges on which the bee leaves the pollen from the anthers in its journey across the flower. S, Stamens. P, Pistil.

flowers are catkins. Of course, all such plants are obliged to produce very large quantities of pollen."

"You mean, because a lot is wasted—blown the wrong way, and so on. The male flowers crowded together in their catkins must make enough pollen to make sure that some of it reaches the female flowers in *their* catkins."

"Exactly. But though these flowers must be extravagant of pollen they can economize in other directions. The individual flowers are very small and inconspicuous because there is no need for them to be large and showy, brightly coloured or scented. There is no need to supply the nectar that insects demand in return for their services.[1] On the whole, the catkin is a very economical arrangement."

"You talk as if the trees had thought all this out and decided which arrangement suited them best," George said with a laugh.

"Trees certainly don't think, for they have no thinking apparatus. But it is none the less true that they have discovered how they can best adapt themselves to the struggle for existence. You said, a little while ago, George, a far truer thing than you knew——

—"You said: 'The trees are just there—always—and so we don't notice them.' That's the trouble. They are so much a part of your surroundings that you hardly give a thought to them. Don't you think that it might be worth while to look at them from a new angle, so that you see them as highly-organized living things? The noblest tree and the humblest weed are alike with ourselves, inasmuch as they share with us the miracle of life. They are feeding, breathing, growing, reproducing themselves. They are organisms with bodily functions as marvellously adjusted

[1] Flowers in catkins are sometimes provided with tiny nectar glands, and some kinds, including the hazel, are occasionally visited by insects.

as our own. And they are fighting things, with wonderful equipment for aggression and self-defence. If once a tribe of plants stops fighting, or loses the power to fight, it will certainly be conquered by its stronger and better-equipped enemies. In time it will be wiped out of existence. And what is true of the individual, is equally true of the tribe."

"But there aren't really conquering cabbages and battling beetroots, are there?"

"Most certainly there are, though you must understand that our cultivated plants have a very much easier existence than wild plants, because the whole purpose of cultivation is to help plants to help themselves. Now, I'll promise you this: As soon as you begin to notice a plant, any plant you like—you'll find that it becomes an individual, having its own character and qualities. You think of your animals as having personalities; you say that one is 'good', another 'naughty'; they are 'sensible' or 'stupid', 'brave' or 'cowardly'. You know well enough that dogs and horses, rabbits and birds, are not really guided by our standards of thought and conduct; you know that those words cannot properly be used to describe their actions, but it is a very natural habit to give our animal friends these human 'personalities', and as soon as ever we begin to study the ways of plants we find that they also possess characters that we come to think of almost as plant 'personalities'. Compare the persistence of the dandelions in the lawn with the wasting away of those rock plants Joan's friend sent her from Switzerland."

"I've often thought I'd like to learn about trees," said Bill. "There are such lots here."

"If only it were not for those awful names," added George.

CHAPTER III

The Green World

Those young people I told you about in the last chapter soon became very keen on plant life. For that matter, they are keen on all sorts of things, and though their enthusiasms are apt to flare up and die out in somewhat fireworky fashion, this particular enthusiasm has kept alive. It flourishes to such good purpose, indeed, that Bill has decided on forestry as a career. He is well on with his training by now and thinks of trees as so many thousands of acres of standing timber, ready for felling, or coming on nicely, or checked in growth to maturity by some pest of which he could tell you the whole life-history. And Joan's garden is of the sort that people come and stare at. "Excuse me," they say, "but would you mind telling me how you get those lovely lilies to grow; they're just like a picture postcard?"

As for George, he's come out strong on fodder. He is a very practical fellow, and having made up his mind that he wants to spend his life among stables, rather than work in an office or a factory, he set to work to study horses and the food for horses. George and the horses always understood each other, and he sees to it that his animals are as well-fed as if they were the most valuable beasts in the country. He is very scientific about it and he studies books and papers and Ministry of Agriculture Reports very learnedly.

Of all the plants that clothe the world, grass comes first

in George's estimation. He sees it as the chief food for horses, both in summer and in winter; and whether as pasture or as hay, it stands to him as so much stored up energy, so much carbon and nitrogen, within his power to control, and divert into horse-power.

He has never overcome his dislike for botanical terms. And though he wanted to share the interest and enthusiasm of the others when they began to discover the wonder and beauty of plant life, he was held back by the bogey of long names. So it came as a great relief to George to discover —as he soon did—that it is possible to traverse a long broad highway through woods and fields and gardens without fear of stumbling over the dreaded snags of unpronounceable names. But it happened that, some time after the catkin incident I told you about, the town friends turned up again, so wonderfully primed with botanical names that poor George found himself obliged to meet them with their own weapons.

" Tell me a good jaw-breaker that will really make them look silly," he begged.

I offered him a mingy-looking little fern: *polystichum angulare divisilobum plumosum densum superbum* was its name, but when we went to look for it, it was found to have died—as it deserved. And there was rather a dull shrub that they were not likely to have heard of—*Acanthopanax Leucorrhizum*—but George refused this when I told him it was a rarity. " Let's have something frightfully common," he said. " A weed or——"

" Then ask them if they would like to see our fine specimens of *brassica oleracea gemnifera*, more commonly called Brussels Sprouts, or a really well-grown example of *cochlearia armoracia*, which most people call a horse-radish. It might work."

It did work. I am pretty certain George got the names muddled, but the botanical friends were much less botanically bumptious when they returned from the kitchen-garden. Joan says that if they read this they are sure to be offended, but I am quite sure that they will not be. After all, it was they who sent Bill and George and Joan forth on a wonderful journey of adventure and discovery. We must give them the credit for that. The town friends went a little way down the secret paths of the alluring world of plant life, and then, like the true explorers that they were, they shouted to the others to " come and look " at the beautiful and mysterious things they had found. I think that was the right thing to do; much better than keeping their wonderful discoveries to themselves. If they put on side over those long names and difficult words, no one was really much the worse. Explorers are often taken like that; it's just a way they have of trying to make you understand how thrilled they are by their discoveries. I dare say, even, that when it comes to *our* turn to open our eyes very wide in astonishment at some marvel of adaptation, some beauty of purpose or of function, we may let out a yell or two in Latin or Greek. But long words shall not hamper or hinder our expedition to the Green Wonder-world, I promise you.

The Green Wonder-world! Imagine yourself set high above the earth, looking down on it, watching the activities of its inhabitants. As you watched, it would not be long before you saw that the principal activity of all the creatures of the earth was concerned with the problem of dinner. Here we are, all of us, grabbing food for all we are worth. Whatever land you chanced to look down upon, you would find that all the animals other than human animals; warm-blooded, cold-blooded, mammals, birds, reptiles, fishes,

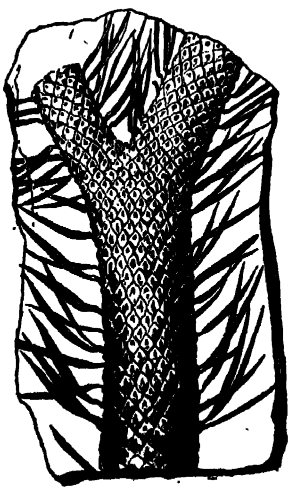
insects—all creatures throughout the realm of animal life —were almost entirely preoccupied in the scramble for food. And when you came to concentrate your attention on the human animals, to find out how *they* were occupying themselves, you would soon discover that the largest proportion of the population in every country is engaged in the business of agriculture. That is the chief industry of every race that makes a claim to be civilized; the growing of crops and the raising of cattle are the true foundations of civilization. Even in Britain, a little country peppered with towns that hum with every kind of industry, more people are engaged in agriculture than in any other important industry, in spite of the fact that we only raise within our own shores a small proportion of the food we require.

Now, all this food is the gift of the green earth, the world of plant life. Most of it—the " staff of life "—as we call it—is given to us directly by the great class of plants that makes this jewelled island, our own bit of the world, so green. These are the grasses. They give us joy as the velvety lawns of our gardens, our playing-fields, the springy, scented hillsides and downs. And more important still, the grasses give the grains that make a great part of our food; wheat and barley, oats and rye; in other lands rice and millet and maize. The sugar cane, too, they give us. And the grasses come into our larder again in the form of beef and mutton, milk and cheese. All animals, whatever they are, obtain their food supplies directly or indirectly from plants. They may get it at second-hand, but get it from plants they must, somehow. In short, animal life is dependent on plant-life.

So all our meals we must seek from the plants, and we range the green earth not only in search of things to eat,

but also for things to drink. We are not satisfied with the good clear water of streams and wells. We demand tea, coffee and cocoa, wines, beers—fermented liquors of a hundred kinds—all of which are products of plants. We cannot even exclude " animal " drinks like koumiss, which is made from milk, and mead, which is made from honey; for the one is derived from grass and the other from the nectar secreted by flowers; while the process which results in any fermented drink is actually brought about by the action of microscopic plants.

Yes, here we are—all the members of the animal kingdom —bound to the vegetable kingdom by an unbreakable bond. All animals are bound thus for their daily food. But the human animal is bound more firmly than any of them, because his needs are so much greater. Consider his clothes. They may be of cotton or linen or silk; they may be of rubber or leather or wool, of animal skins, or of wood-fibre or cocoa-nut fibre or of palm leaves; whatever they be, they can only be obtained from the same inexhaustible treasure-house we have already seen as the source of all that goes into the larder.



A fossil coal plant (a giant horse-tail)

Next, when we have grown or culled or killed our food, how do we cook it? How do we warm our houses and keep a great part of our machinery going? Each shovelful of fuel that goes into our grates and furnaces is a compound of carbon. This carbon is the chief source of our energy, alike in our bodies and in steam engines and gas engines;

Plant life in the coal age. This is what a forest from which the coal-beds were formed looked like.

and it all comes to us from the tissues of plants. Most of it is in the form of coal, which is composed of the fossilized remains of plants which flourished millions of years ago. It is not quite certain whether the mineral oils that provide our liquid fuels, paraffin and petrol, are or are not a product of transformed vegetable matter, but there are very strong grounds for supposing that mineral oil may have had a vegetable origin.

In whatever direction we look, we find ourselves looking upon some object which reminds us of our debt to the world of plants. Some of the treasures in the inexhaustible treasure-house of vegetable life carry upon them plain marks of their origin. We recognize potatoes and bananas as vegetables; bread and cotton and rubber are never far

separated in our minds from the fields and plantations where they grow. But there is a host of things we daily use in which the vegetable is so completely disguised that it does not appear unless we search for it. Vast quantities of vegetable fats and oils appear before us as soap, as margarine and as the fats used in " shortening " biscuits and cakes. Nearly every pair of boots owes something of its usefulness to castor-oil, the nasty stuff that most of us have had forced upon us, at some time or another, as a particularly horrid physic. The chemists' shops are stacked with drugs that come from plants. But there is no need to continue the catalogue, for there is hardly a shop of any sort in which the wares are not drawn in large part from vegetable products. Perhaps the china shop owes least to plants. But even the china merchant has need of packing materials—shavings and string and paper.

Paper is only another name for wood, for all but a very small proportion of the paper used nowadays is one of the products of the forest. (The remaining small proportion, being made either from a kind of grass or else from cotton or linen rags, is also a vegetable product.) " Touch wood " you say; and indeed there is nothing you are more likely to touch, wherever you put out your hand. Wood, recognizable wood, is quite the most familiar of the substances surrounding us. Wood floors and doors, wood furniture, matches, pencils—you can go on with the list for yourself. I dare say you share with me an unending wonder as to where all this wood comes from. I believe we all feel some surprise at the profligate carelessness with which we use timber, for we all know how slowly trees grow. Some of us get quite anxious and worried sometimes because we know that the great natural forest-belts of the world are being used up much faster than the new forests are being

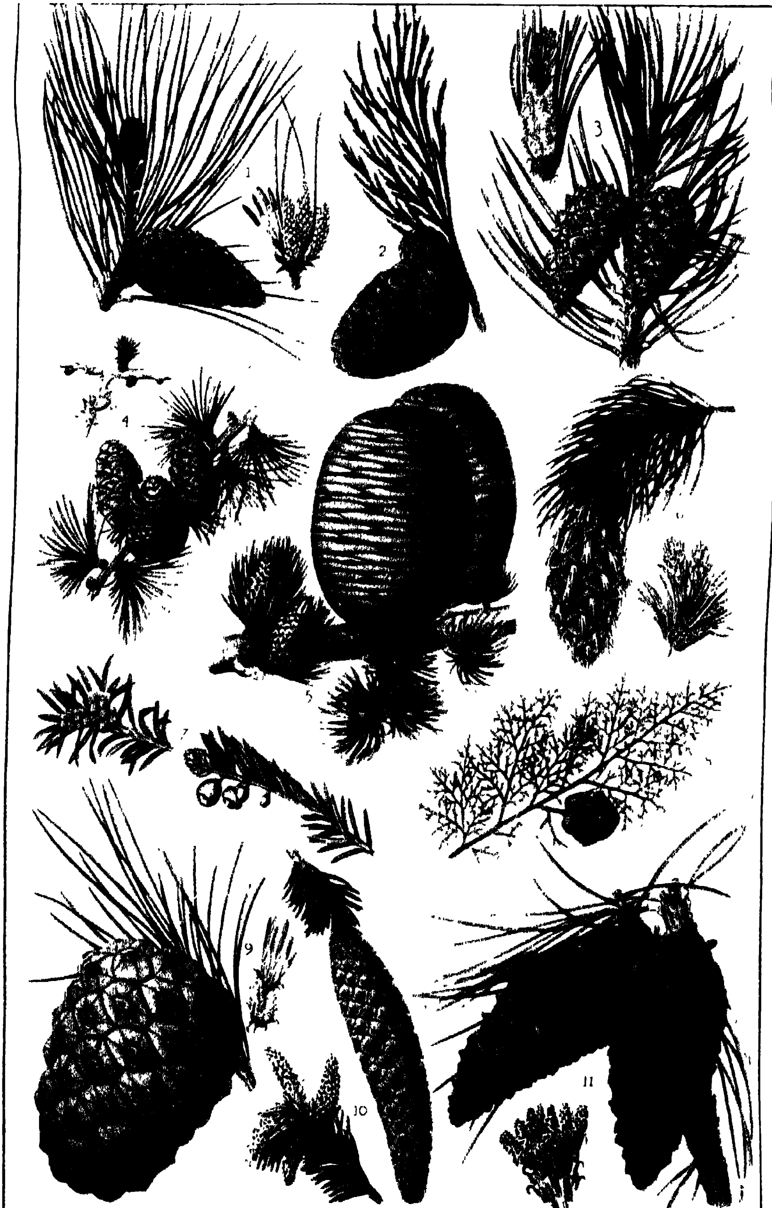
made. You probably get several different sorts of thrills when you think of a railway line; there are so many fascinating trains of thought to follow. Do you ever give a thought to the sleepers which provide a resilient, easily adjusted bed for the rails? Do you ever think of them, not as separate balks of timber, each 9 feet by 10 inches by 5 inches, but in bulk, the product of many square miles of forest which cannot be replaced in less than thirty years? Of course you don't. No one thinks of sleepers in such a way unless he is a forester or a timber merchant or a railway engineer. But I think the sleepers may give us rather a vivid picture of what wood really means in relation to our needs. Only, you must note that sleepers are not " just wood "—they are selected Baltic pine of very high quality. They are laid 2 feet 6 inches from centre to centre, which gives 2140 to the mile of single track. There are about 20,000 miles of railway in Great Britain, so the total number of sleepers works out at about 43 million. The effective " life " of a sleeper is 15 years, consequently the quantity required for renewal amounts to several million each year.

Now let us take a world survey. Though Britain has a large railway mileage in proportion to its area, our 20,000 miles of track is a very small proportion of the world total. There are more than 760,000 miles of railway in the world, and nearly all of it is laid on wooden sleepers.[1] We are left gasping at the thought of the millions of trees needed to maintain the smooth passage of the world's railway trains. At least one American railway grows its own sleepers, on a tract of land the size of an English county. Each year they

[1] In a few tropical countries steel sleepers are used. During the past few years experimental lengths of track have been laid with steel sleepers in Britain. Such track is found to be noisier and " rougher " and less easily maintained than the standard timber-laid track, and wooden sleepers are unlikely to be abandoned unless a change is forced on engineers by a shortage of suitable timber.

plant trees to keep the supply going—enough to cover a square mile of their land.

We have wandered a long way from the china shop however. The palpable wood track of railway sleepers was not the track I intended to follow when I bought a penny egg-cup for the sake of the paper it was wrapped in. So I will say, once again, that paper is only another name for wood. Wood masquerades in many unrecognizable forms nowadays! Reduced to the substance called cellulose the forests are presented to us again as artificial silk—or rayon, as the makers prefer to call it; and still again as the beautiful cellulose paints that have brightened a multitude of homes. But they are only as drops in the bucket compared with the paper business. The forests are being emptied so that we may wallow in a veritable sea of paper. Think of the papery litter man leaves—wherever he goes, whatever he does. Newspaper, wrapping paper, boxes, cartons—for these things trees are going to the pulp-mills in a vast unceasing stream. Those millions of sleepers would not go far to maintain the stream—even if the pulp-makers could get them. In actual fact, the pulp is made from small trees, unfit for the needs of timber merchants. But the sweep of the axe is terrific, and a startlingly wide stretch of woodland must be laid bare to satisfy our need—or our supposed need—of paper. I am not going to worry you with statistics, but I may just tell you this: that to meet the requirements of American newspaper readers alone (it is true there are 122 million of them and they have a perfect passion for print), some fifteen acres of woodland must be turned into pulp every day.



LEAVES, FLOWERS AND FRUITS OF SOME CONIFERS

1, Corsican Pine. 2, Wellingtonia. 3, Scotch Fir. 4, Larch. 5, Cedar. 6, Douglas Fir. 7, Yew. 8, Cypress. 9, Stone Pine. 10, Spruce Fir. 11, Cluster Pine.

CHAPTER IV

Some Sorts of Vegetables

The postman had brought for Joan a very exciting packet. It was from a friend in one of the provinces of Central China, and it contained seeds of a very beautiful kind of azalea. Joan's friend thought that it would grow well in an English garden.

" Will it?" asked Bill, doubtfully.

" Oh, yes, I think so. But don't open it now, Joan——"

The warning was too late. Joan opened her little envelope, while Bill leant over her chair to watch. Without thinking he started to whistle. A puff of his breath caught the seeds, which were almost as small as specks of dust, and blew them on to the breakfast table.

We swept them into a little heap, and held our breath while they were collected on a sheet of paper. There seemed to be far more crumbs than seeds.

" Even if the azaleas don't grow, you ought to get a jolly good crop of Bread-fruit trees," Bill said, but Joan was not to be appeased. She said his jokes were just about as clumsy as he was. She wanted to go out and sow the seed immediately, before further misfortune befell.

" Where will you sow them?"

" In the garden, of course."

" I shouldn't think they'll have much chance, anyhow," George said. " They're so small—they're more like powder

than seeds. I bet they'll get lost, even if the wind doesn't blow them away. I say, are they *really* seeds?"

He might well be astonished at their smallness, seeing that these were seeds of a shrub that grows about five feet high. I agreed that it hardly seemed possible, but it was none the less true that each of those minute specks was a living plant. It did not differ, except in detail, from big seeds like beans and acorns. Inside its horny covering was a tiny azalea, with two leaves pressed close together, and a bud that would grow downwards to make a root, and another that would grow upwards to make a stem. It also contained a supply of food to keep the baby plant growing until it was old enough to find nourishment for itself. It certainly was a very small seed, though some seeds are smaller still. But these were much too small to risk in the garden. I said we must give them every chance.

Later on we sowed the seeds with due rite and ceremony, Joan and I. I found a seed-pan and Joan scrubbed it—under protest. The seed-pan is like an ordinary flower-pot, only wider and not so deep.

"Why must I scrub it in hot water and soda? It isn't dirty."

"We can't be sure of that. The pan is supposed to be porous, so that air and moisture can penetrate all parts of it. But it has been used before for growing seeds in, and the pores are probably clogged by the growth of multitudes of tiny plants. Yes—I thought as much. Look here."

I held up the seed-pan so that the light revealed a faint misty green on the dull red of the earthenware.

"Those plants would spoil the perfect conditions we are trying to provide for the seeds of your precious Chinese azaleas."

" They don't look like plants," said Joan, doubtfully. " It looks more like a stain."

" They are minute green plants, and as soon as the seed-pan became damp again, they would start growing, and would go on growing until they had filled up the pores of the pan. They would grow on the soil, too, and stop the air from getting into that, to the detriment of your seedlings. Have you ever seen seaweed?"

" Of course I've seen seaweed," she retorted. " Oar-weed and bladder-wrack and sea-lettuce—that green filmy stuff—and—oh, lots of other sorts."

" This ' green stain ' on the seed-pan is one of the ' other sorts '," I told her. " It is not a seaweed itself, but a poor relation of the seaweeds. Like them, it belongs to the great division of plants called *algæ*. Some of the algæ or water-plants are very large; some are so small that they are mere microscopic specks. That water-butt and the horse-trough contain millions of them. . . . Is the seed-pan clean? We'll put it in the wind to dry, while we mix the soil for it. You can get out a trowelful of sand from the bin in the corner, and a trowelful of soil from under the potting bench."

" Perhaps that ought to be scrubbed too. I expect it's full of seaweeds—millions of them," said Joan, who was still rather scornful of the hot soda-water treatment.

" Thanks, but that has been done already."

" Not *scrubbed*?"

" Well, not actually scrubbed with a brush, grain by grain. You see, it's easier to do it in bulk; so we sterilize it by cooking a sackful at a time. It saves a heap of trouble."

" What sort of trouble? Does it save the little seedlings trouble, or only you—us, I mean?"

" All of us, the seedlings included. One reason why we cook the soil is to kill weed seeds, which are a dreadful bother in a seed-pan; and to kill insects and their eggs. But chiefly we cook it to kill plants that are much too small to see, though we know they exist in the soil, and would thrive and multiply at the expense of the seedlings we are hoping to raise."

" But if they're as small as all that, what harm can they do?"

" Do you know what mushrooms are, Joan?"

" You *do* ask idiotic questions! You know I know what mushrooms are."

" Good. Then you will be prepared to agree that a mushroom is a fungus; and that fungi comprise a class of plants which do not derive nourishment directly from the soil, but from the tissues of plants and animals, either alive or dead. The mushroom feeds on dead organic matter, but it has a host of relations which live on the tissues of *live* plants. Some of them are very small, far smaller than the algæ you killed by scrubbing the seed-pan. But these microscopic fungi can hinder the growth of our seedlings, making them become ill, and perhaps killing them. If we purify or sterilize the soil, however, we kill the spores of the fungi—that is, the germs by which they multiply—and all is well."

" I see. Then our seeds are certain to grow, aren't they, because our soil is ab-solutely germ-proof."

" That's the trouble. You see, it may be *too* germ-proof —or rather germ-free. It is difficult to kill the harmful microscopic plants in the soil without also killing the useful microscopic plants. We have to be very careful not to heat the soil too hot, or we are in danger of destroying the bacteria as well as the fungi."

" But I thought bacteria were the things that give you diseases."

" So they do—dreadful things, some of them. Bacteria are simple microscopic plants of many different kinds, but of one particular type. Some of them live in the soil. Some do harm to plants, and those we want to kill. But some do good. In fact, if they were not there, in the soil, our plants could not grow and flourish. Soil is a most amazing mixture of *inorganic* things, like rocks and chemicals, and *organic* things—living things like the microscopic plants called bacteria. These bacteria are necessary for the nourishment of the more highly-developed plants—the plants we want to grow—so we must be careful not to kill the *good* bacteria, as well as the bad."

" Well," said Joan, " all I can say is, what an *estrordin'ry* lot of plants there must be."

If you set forth to explore in the realms of the vegetable kingdom, your first emotion may be one of bewilderment. There seem to be so many paths in those realms, all dimly lit, and it is hard to know which path to follow. They are peopled, too, by so many *invisible* denizens—plants that live in the air you breathe, and in the waters, and in the soil under your feet. And even if you keep your attention fixed on the visible, tangible plants—the trees and herbs—you are likely enough to echo Joan's profound but imperfectly expressed sentiment—what an *estrordin'ry* lot of plants! The more closely you look about you, however, the more quickly does the light come through to the path you have chosen to explore; and before long the first bewilderment has given place to a great and lasting wonder at the amazing powers of adaptation, and the perfection of function and of form, of these myriad kinds of vegetable life.

I told you the story about Joan's seeds because I want to take you on a lightning tour of the vegetable kingdom; to show you, very quickly, its chief divisions—its provinces, we might say. Because, if we are going to ask the plants to reveal to us their secret wonders, we must know how the different members of the great kingdom stand in relationship to each other. Later on, you will want to learn more about these relationships from a proper botany book, and I can promise that you will find them extremely interesting. We cannot get very far towards understanding the ways of plants until we have sorted them out into different classes, each distinct from the others. We must arrange them in some orderly array, according to differences and resemblances. We cannot study any collection of things until we have done this, no matter whether they are living things or non-living, whether they are animals or plants or postage stamps, sticks or stones or stars.

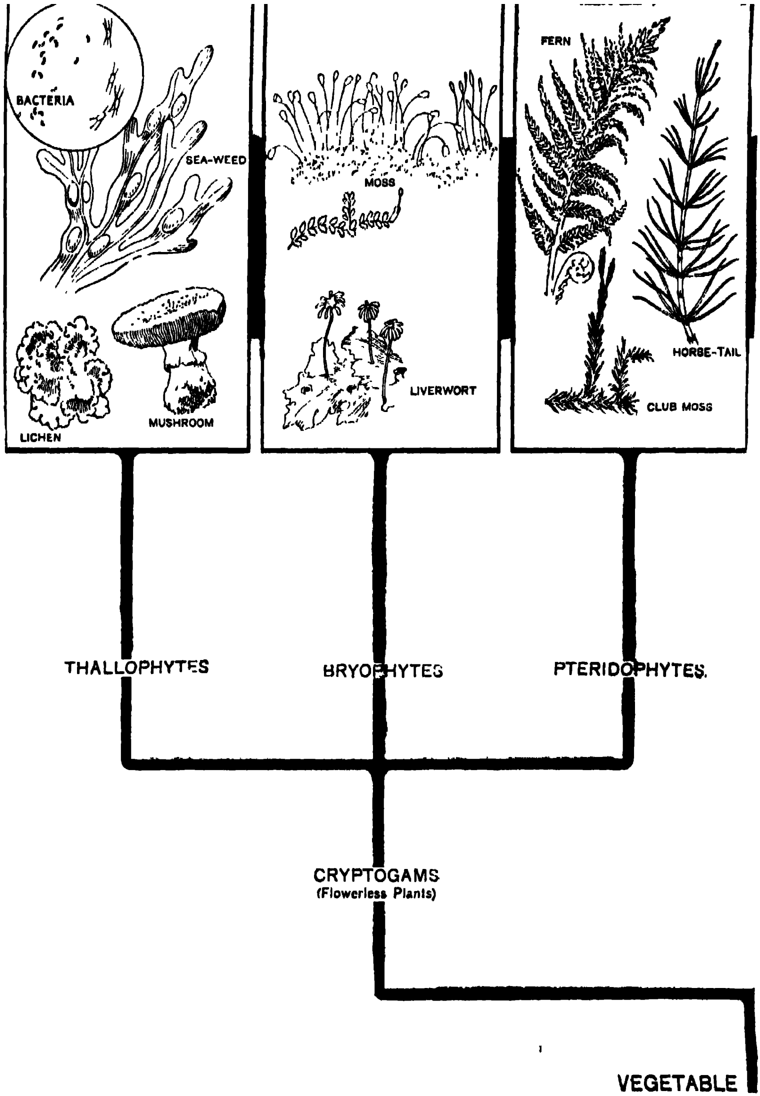
Whenever we think of an animal, we at once put it into a class. In the case of common animals, those with which we are familiar, we do not have to think about the class to which it belongs. They go quite easily into the pigeon-holes of our mind. Though we may not know the exact characteristics by which zoologists are guided in sorting out animals, we know the broad distinctions well enough. We know that mice and men are *mammals*, that thrushes are *birds*, that adders and alligators are *reptiles*, and salmon and sharks *fishes*. We know, too, that these four *classes* of animals, together with a fifth class, the *amphibians*—creatures like frogs and toads that go through a tadpole stage—these five classes together make the great animal division called the vertebrates. All those animals have a spine, a vertebral column, to hang their bones on. All the other classes of animals together form a second great division

called the invertebrates, because, not having skeletons, they have no spines.

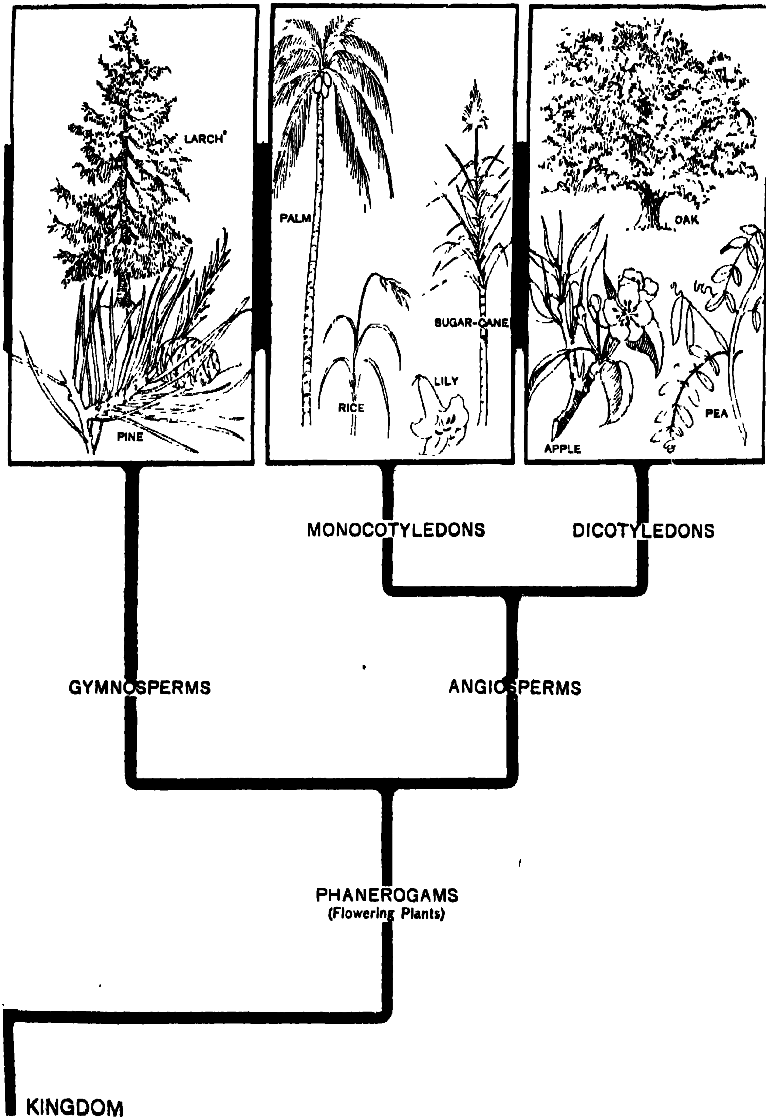
The members of the plant world are arranged on exactly the same principle. There are tens of thousands of different kinds, and the first thing to do is to separate the kinds into groups or divisions having the same characteristics. Anyone would agree that a toadstool is as much unlike a rose as a horse is unlike a snail or a crab. And as soon as we examine a rose and a toadstool, we see that they really do differ, not merely in appearance, but in the ways in which they obtain their nourishment and produce their young. An oak tree is unlike a rose, too, at first sight; so is a cabbage; but we soon discover that oak, rose and cabbage are all made on the same principle, and perform their vital functions in a similar way. They clearly belong to the same plant province, or main division.

Having obtained the main divisions of the vegetable kingdom which I have called the provinces, it becomes much easier to arrange the plants we meet with in smaller groups or sub-divisions within the main provinces. We can class together a great variety of plants having the same general characteristics. "All these and all those," we say, "are alike in certain respects." Then we divide them up again, sorting them out into smaller and smaller classes, until at last we are able to include in a single group all the plants which have their parts arranged in a particular fashion. Such a group is called a *Natural Order.*

But there still remain smaller differences in the plants grouped thus in a Natural Order. When we have sorted out from among the animals the cats and the dogs, the bears and the hyænas, it is obvious to us that though those animals are alike in being *carnivores* or flesh-eaters, they are yet markedly different from each other. There is a



THE DIVISIONS OF THE



VEGETABLE KINGDOM

great cat tribe and a dog tribe and a bear tribe, and within those tribes are many different sorts of cats and dogs and bears. So it is with plants. Within the Natural Orders of the plants there are many different groups. Each group is called a *genus.*[1] But even when we have got as far as the genus there is still a great deal of sorting to be done.

If you go into the garden you can soon find a buttercup; at least it must be a very strange garden if you cannot. If you look a little more carefully you will come upon another *sort* of buttercup, very similar to the first sort you found, but not quite like it in every respect. If you go into the meadow you will probably find a third sort; while down by the stream there will be still another sort. Each sort of buttercup is a *species* of the buttercup group or genus. Although the parts of the flowers of all the sorts are all arranged in the same way, there are little differences by which we are able to know one from another. We can easily find four or five species of the buttercup genus. The Latin name for this genus is *ranunculus,* and the same name is given to the Natural Order to which it belongs. In the garden we can find a great many genera belonging to this Natural Order: anemones, pæonies, larkspurs and columbines, Christmas roses and clematis. These flowers do not *look* much like buttercups certainly, but when we take them to pieces and examine them carefully we see that they have resemblances in common. Though they are distinct groups or *genera,* they all have a family likeness.

It will be worth taking a little trouble to get the main plant divisions sorted out at the very beginning of our exploration. The first division of all is easily remembered. We can divide all plants into two great groups:

[1] *Genus,* plural, *genera,* is a Latin word meaning *birth.*

(*a*) Plants which bear seeds.
(*b*) Plants which do not bear seeds.

The first group, which includes all the flowering plants —all the herbs, shrubs and trees—is called *spermaphyta*; *sperm* being the Greek word for seed. The great majority of these flowering plants have their ovules—the future seeds—protected in little boxes or cases, called carpels. They form a great division, known as *angiosperms*: that is Greek for " seed cases ". In the other, and much smaller, class of flowering plants, the seeds are not enclosed in little boxes. So they are called *gymnosperms*, meaning, the *naked* seeds. The cone-bearing trees—pines, firs, larches and all the rest—are members of this class of flowering plants.

Now for the plants which do *not* bear seeds. They constitute four out of the five great provinces of the vegetable kingdom. Province I, the flowering plants, we have just seen. Here are the others:

II. Ferns, and fern-like plants.
III. Mosses.
IV. Algæ, Fungi, and Lichens.
V. Bacteria.

The ferns have roots and stems and branches very much like the seed-bearing plants. *But they don't bear seeds.* Instead, they produce tiny dust-like *spores*. A seed is a highly-complex structure built up of a great number of separate cells, some of which have quite distinct functions. A spore is a single cell. When it leaves its parent fern it grows, not into a new fern, as a seed grows into a new plant exactly like its parent, but into a tiny flat plate (a thallus) which is not a fern at all. This independent green speck of

a " plate " presently produces male and female cells which unite to form an *embryo* which grows into a new fern.

The mosses not only have no seeds; they have no roots either, in the true sense. And the next group, the algæ, fungi and lichens, are still simpler in structure and in the arrangement of the cells. Some of the algæ are huge sea-weeds, forming the longest plants in the world; others are microscopic in size and only when they exist in millions, as when they make water cloudy, are we aware of them with the naked eye. The fungi (the larger sorts of these we know as mushrooms and toadstools) are very odd plants. They don't need light. They have no chlorophyll, the green substance which with the help of sunlight plays a vital part in the nutrition of all other plants, as we shall see in another chapter. Fungi are the only plants that can grow in the dark. Because of this they get their food at second hand, feeding on other vegetable or animal matter, or on the products of such matter when it has decomposed. And as for the lichens, which grow just everywhere, I am not sure these are not even more remarkable than all the others, for every lichen is a wonderful sort of partnership. Part of it is an alga and part a fungus, each performing a separate duty and sharing the combined profits.

The lowest and simplest plants are those in the fifth division. They are the bacteria, of which there is an enormous number of different kinds. They are all very, very tiny; some, indeed, are so small that they cannot be seen even with the most powerful microscope, and we assume their existence only because of their effects on living tissues, these effects being similar to those caused by the bacteria which *can* be seen. Many of them are the " germs " of diseases, both of animals and plants; but others of the bacteria are not merely useful, they are essential to all

other forms of life. They are the principal cause of the fertility of the soil, and with their aid the higher plants obtain their nourishment.

The chief difference between the members of the five provinces of the vegetable kingdom, as we ascend from the lowest to the highest, is the development of specialization, or the *division of labour*. The highest and the lowest, the loveliest rose and the humblest bacterium or alga, start life as a single cell, which undergoes division until it has given rise to a multiplicity of cells. But whereas in the lower plants the cells always remain the same in kind and function, in the higher plants the original germ-cell gives rise to a great variety of cells of widely different functions. This means that in the flowering plants different kinds of cells have allotted tasks to perform. Some carry on the nourishment and growth of the plant as a whole, while others attend to the highly-specialized development of particular parts of the plant—roots, shoots, leaves, flowers and fruits—giving to these parts the power of adaptation and the variety of form which makes them such fascinating subjects for study. In the following chapters I hope to show you something of this marvellous power.

Here is a little map of the vegetable kingdom, drawn to show you examples of typical representatives of the five provinces. We have put some long words in, too, which you can learn if you like, but perhaps not. But if you say them to yourself, quite slowly, I think you will find them quite nice-sounding words, because they are mostly Greek, and Greek words have much music in them.

But here is a thing I had nearly forgotten. We have been talking of the vegetable kingdom, but do we all know what we mean by that? What is a vegetable? We know it is a form of that very mysterious and wonderful force we call

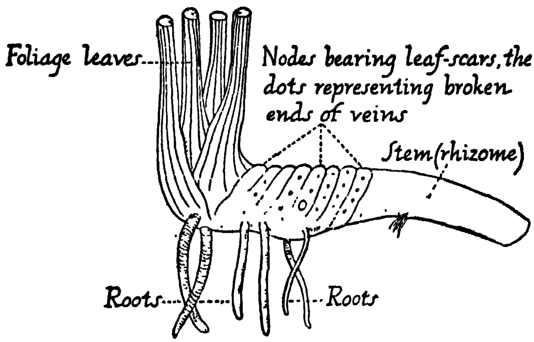


Diagram of the rhizome of an Iris

life. But what sort of life? Perhaps you will say that a vegetable is a form of life that does not move; it has to stay put. That won't do. Some animals don't move—or only a very little. The sea-anemone, for instance, and its cousin the coral polyp, stay glued to their rocks, once they are grown up. And some vegetables *do* move. Some of the bacteria and some minute water-plants, or algæ, can " swim " very vigorously by thrashing the water with odd little oars called *flagellæ.* Even many of the highest plants have some power of movement. The flag-iris flowers which bloomed this year did not come up in quite the same place as last year's blooms; they came from buds on the underground root-stock a little distance away from last year's buds. And the bramble is slowly walking along the hedge. The long arching shoots reach down and touch the ground, and then the tips of the shoots take root and form new plants some distance away from the parent plant. The banyan tree, which grows in eastern countries, extends in a similar way. The branches arch downwards and grow when they touch the ground, and so the banyan is always spreading farther and farther afield. There are lots of

plants whose habits convince us that they have a power of movement.

We must look for a better difference between animals and vegetables than movement. We find it in the manner in which they absorb their food. Every animal, even the humblest, has a mouth and a gullet through which it can take in food in a *solid* form. No plant can absorb solid food, and so it has no need of mouth or gullet. Plants always take their nourishment from chemicals dissolved in water.

CHAPTER V

How Plants Grow

In the autumn, one of the familiar sounds of the country-side is the ring of the woodman's axe. To some it is a mournful sound, and the sight of the fallen trees is sad. But pass by the same ground in the spring, eighteen months later. Where the trees have been felled there will most probably be a carpet of primroses and windflowers, the most joyous heralds of the earth's awakening.

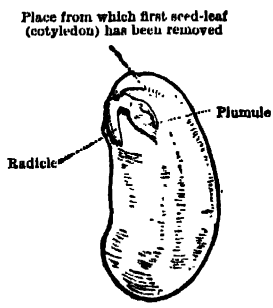
It seems a miracle, but there is no miracle. The amazing generosity of Nature scatters seeds far and wide without any regard to the requirements of the plant-to-be. In every stretch of woodland the soil is rich in seeds dropped by birds, brushed off the coats of little animals, or carried in on drifting airs. Only when conditions are right do the seeds germinate and the seedlings survive. When the removal of the heavy curtain of the trees admits to the soil a sudden rush of light and air and rain, the seeds, instead of perishing almost as soon as they start into life, are able to grow very actively. For the next few years the clearing is a paradise for low-growing plants, which thrive in the rich leaf-soil. But gradually the trees reassert themselves. The undergrowth of brambles and ivy strangles and smothers the smaller herbs; off-shoots and "suckers" from the stumps of the felled trees, as well as seedling trees, grow apace and shut out the sunlight and the rain, till impercep-

tibly a new woodland has come into being and the primroses have dwindled and died.

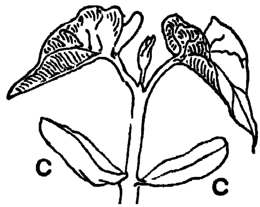
Another instance of Nature's bounty occurs whenever a piece of ground is cleared—even if it be by the demolition of a building in the heart of a city. The bare earth thus exposed produces in an incredibly short time a crop of young green things which, if allowed to grow, will reveal themselves as poppies, mayweed, chickweed, groundsel, nettles, thistles, docks and many more. Where they have come from is a mystery, but we know that the seeds are always being blown about and carried about the streets in one way or another, to spring into life as soon as they come to rest in a little corner of soil.

But how and why do they *grow*? The science of growth is much the same in both plants and animals. The structure of all living things is simply a system of cells, and growth in all living things is a process of cell division. Behind that, of course, is the intangible force of *life*, which we can destroy, but cannot create.

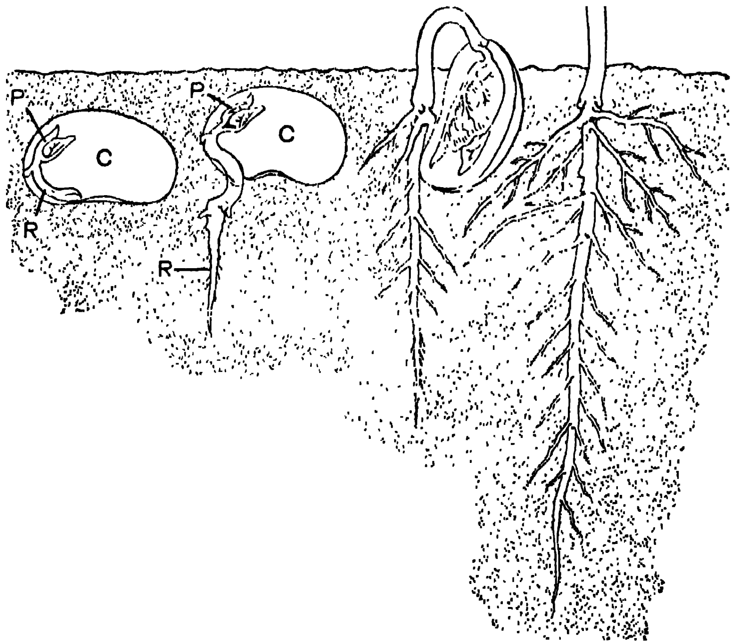
When a seed leaves its parent it may fall direct on to the ground, or it may be wafted by the breeze, or it may be carried by a bird or an animal. Or it may fall on to the market gardener's basket or sack—still more easily into the " turn-up " of his trousers—and be carried miles away by motor-lorry. Whatever happens, it ultimately comes to rest. Now, if conditions are favourable, it starts to grow. It needs a little soil, a little moisture and warmth. Given these three factors, it *germinates*, that is to say the germ of life causes the cells contained in the



Seed of scarlet runner. One cotyledon has been removed

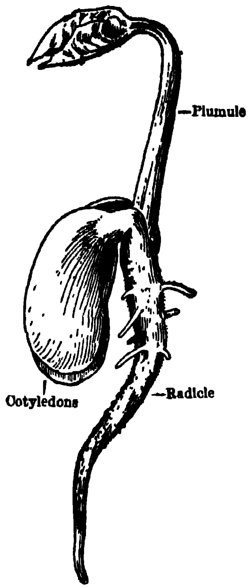


Four stages in the growth of a bean (dicotyledon). One cotyledon has been removed in the first three views. C, Cotyledon. P, Plumule. R, Radicle. In the last picture the cotyledons are shrivelling up.



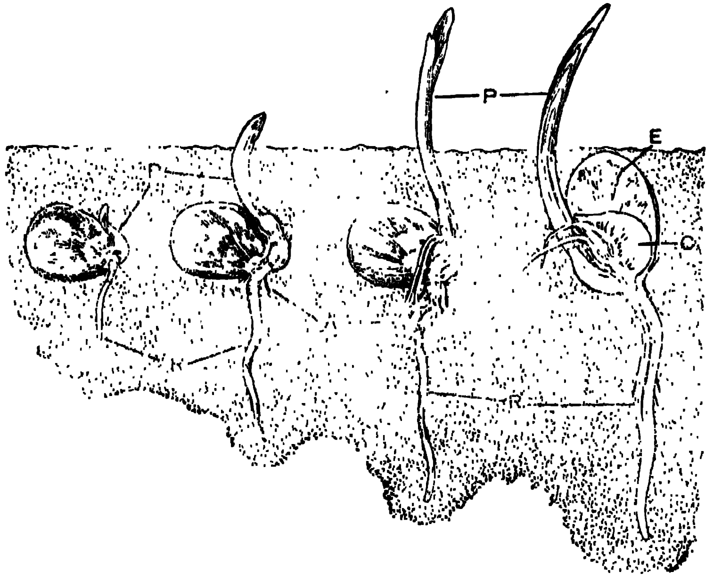
seed to begin to grow and divide. Look at the picture (p.49) of a seed; it has two little stores of food, called *cotyledons*, one little sprout called the *radicle*, which grows downwards and makes a root, and another little sprout called the *plumule*, which grows upwards and makes the stem.

But before we go any farther, it will be as well to get to grips with these unusual words. Cotyledon (kot-i-le-don) is the name given to the seed leaves because they are often slightly cup-shaped, *kotyle* being the Greek word for cup. *Radicle* is easy; we have almost the same word in radish and in radical—the redhot sort of politician who means to get at the *root* of things. The radicle of the seed, the radish and the radical reformer are all closely connected with the Latin word for *root*, while plumule is nearly the same as plume, from Latin *pluma*, a feather. I don't know how or why a feather was chosen to represent the bud in the seed which springs up to make the stem, for it certainly is not very feathery.



A germinating bean showing clearly the two cotyledons

The seed in the picture is that of a *dicotyledonous* plant. It has two seed leaves, or *cotyledons*. Most plants are provided with these two separate little stores of food—nearly all our friends in garden and forest. But the inhabitants of lawns and meadows display a different arrangement. The seeds of grasses have only *one* seed leaf, so there is only one little store of food, and the *embryo*, or growing part of the seed, is at one end. Plants of this kind are *monocotyledonous*. The shape of the two seed leaves of the dicotyledons is quite unlike the shape of the leaves that will grow on the plant later on, but they grow quickly to start gathering food. The monocotyledon sends up only a grass-like blade, and this is the kind of foliage it bears throughout its life. Irises,

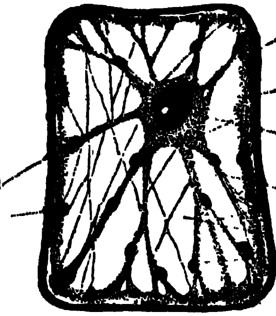


Four stages in the growth of a maize seed (monocotyledon). P, Plumule. R, Radicle. A, Adventitious roots. C, Cotyledon. E, Endosperm

lilies, onions and palm trees are familiar plants that are monocotyledonous, like the grasses.

And now we get back to our question " How do plants grow?" If you look through a thin leaf or petal held up against the light you will see that it is built up of cells, somewhat similar to those of a honeycomb (only the divisions you see are much more irregular in shape. They are gatherings of many kinds of cells. You will need a microscope to show the individual cells). At certain points in the structure of the plant the cells of which it is built up form what is known as *meristematic* [1] or generating tissues. These are " growing points " and the cells at these points are very small and have very thin walls. Each cell is full of *protoplasm*—which is the name given to the mysterious " life-

[1] Meaning " dividing-point ".

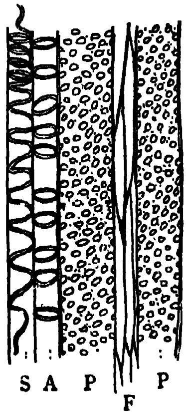


A very much enlarged diagram of a cell

substance "—and contains a *nucleus*.[1] The cell wall is built up of a substance called *cellulose* which is a combination of carbon, hydrogen and oxygen ($C_6H_{10}O_5$). Cellulose is much the same in composition as sugar and starch. Protoplasm contains nitrogen and sulphur in addition to these. As the plant draws nourishment from the soil and air so does its store of protoplasm and cellulose increase. In course of time drops of water—cell-sap—appear within the protoplasm. In favourable circumstances, the nuclei in the cells periodically divide, the two portions retiring to a little distance from one another. Each portion then surrounds itself with a new wall, so forming a new cell, which increases in size until *its* nucleus is also ready to divide. The cells go on increasing in number, and as they age, spaces containing cell-sap—*vascular spaces*—appear. In cells forming the harder tissues, such as wood or cork, the protoplasm gradually disappears, the cell wall becomes hard and the cell contains nothing but air or water. This is the death of the cell, which can develop no further when it loses its store of protoplasm.

The tissues formed by cells are classified according to the shape of the cells, as each kind of cell has some different

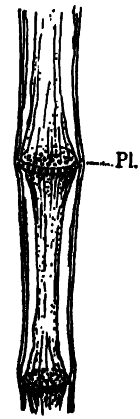
[1] Plural *nuclei*.



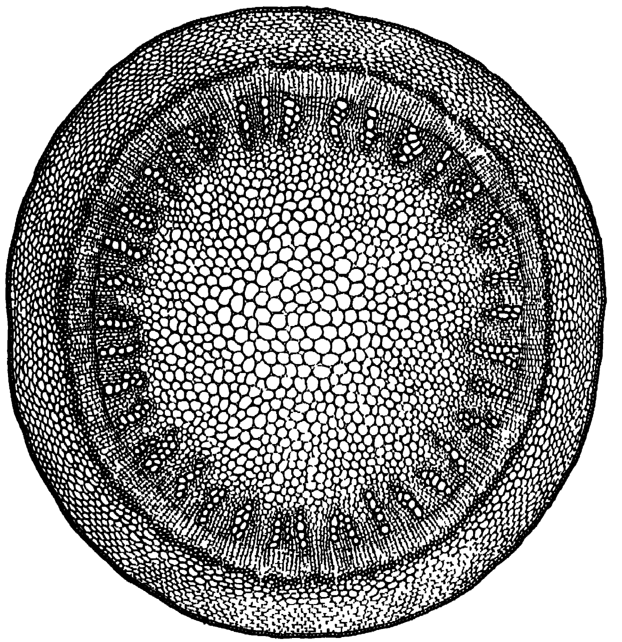
Various vessels showing the cells composing them. Highly magnified.

S, Spiral vessel; A, Annular vessel; P, Pitted vessel; F, Fibres in the wood of a fibro-vascular bundle.

function in the plant. The classes have rather terrible names, but it is worth while to try to learn them because you will constantly meet them when you begin to study botany. Tissue composed of rounded cells is called *Parenchyma*; that of oblong cells is called *Prosenchyma*, and that of cells having thickened cell walls (the worst of all) is *Sclerenchyma*. Cell walls thicken in a variety of ways. Sometimes the thickening takes a spiral form and sometimes a hooped form, these two kinds being known as *Spiral* and *Annular* cells respectively. Or the pattern may be *Reticulate* or *Pitted*. Cells of these various kinds form themselves into *vessels*, when one cell is placed above another and the dividing walls disappear, leaving a continuous tube which is known as a spiral, annular, reticulate or dotted tube, according to the kind of cell composing it. Sometimes the dividing wall does not disappear but becomes perforated, in which case the vessel is called a *sieve tube*. The vessel, or hollow tube, contains nothing but air and is found in the woody parts of a plant; whereas the sieve tube is a means of conveying food substances from the leaves to the other parts of the plant. In other cases the cells become very much lengthened on account of pressure on their sides, and are then called *fibres*. These generally occur in conjunction with vessels, and the tissue thus formed is called *fibro-vascular* tissue. Only the higher orders of plants have vascular tissue of

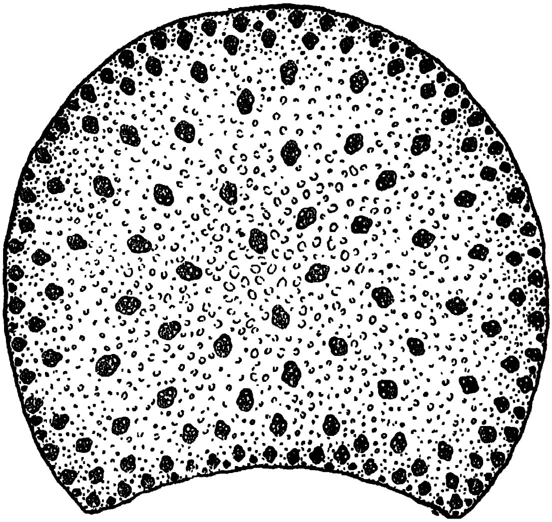


A sieve-tube, showing sieve-plate Pl. between the cells. Highly magnified.



Transverse section of a young dicotyledon (Ricinus): the regions, beginning outside, are epidermis (single layer of cells); cortex (a zone of several layers), including an almost continuous band of fibrous cells (heavy walls); a zone of several layers (the outer ones being phlœm, the inner cambium); the zone of xylem strands (separated by pith rays, the innermost vessels in each strand being protoxylem, the outer and larger ones metaxylem); and the pith. (After Coulter, Barnes and Cowles.)

this kind. The elongated cells and fibres together are called *fibro-vascular bundles* from their arrangement and they act as " sinews " to the stem by giving strength and pliability, and they compose the " skeletons " of leaves. The arrangement of the fibro-vascular bundles also constitutes one of the differences between monocotyledonous plants and dicotyledonous. In the case of monocotyledons the fibro-vascular bundles are scattered about in the fundamental tissue; whereas in dicotyledons they are arranged in definite rings. The centre of the stem holds the pith, or *medulla*, consisting of parenchyma which stores food and



Transverse section of the stem of a monocotyledon (corn) showing the scattered vascular bundles. (After Coulter, Barnes and Cowles.)

water. Radiating from the medulla and lying between the fibro-vascular bundles are lines of parenchyma carrying food to the outer layers of the stem. These are the *medullary rays*. They form the lines you can see radiating from the centre of a tree log, and in a longitudinal section of a tree, such as a plank, they appear as the wavy lines we call the grain.

The cells engaged in active growth are those which, as we have seen, are composed of meristematic tissue and they occur at definite points of a plant, called growing points. These points originate in the stem, where tiny buds lengthen into shoots, on which more buds develop into flowers and leaves. Even then the tale is not quite told, for growing points on the edges of leaves make lobes and leaflets. Growing points primarily are at the apex of the shoot, but soon the cells at the apex die and the growth

then continues from points immediately behind the apex. This is the spot from which elongation takes place most rapidly.

In the root, growth takes place in a similar manner. But as the hair-like chains of cells with which roots are furnished have a considerable amount of friction to withstand, the apex is provided with a root-cap, made of harder cells, which is continually renewed as it is worn away by friction with the soil.

Apart from food and moisture which the roots collect from the soil, the growth of plants is dependent upon light. This does not mean, however, that the greater the light the quicker the growth. If you take two pieces of potato and plant one piece in the open ground and the other in a cellar or dark cupboard, the piece that is in the dark will send up long shoots a considerable time before the other will have made more than a small sprout above the surface. But the plant grown in the cellar will have very small leaves, few and far between; that is to say, the internodal spaces will be greatly elongated; while the plant growing in the open will make short, bushy stems with large leaves. We shall see presently what an important part the leaves have to play in assisting the plant to grow.

As I told you in the last chapter, all plants, with the exception of the fungi, contain a substance called chlorophyll which is formed in the protoplasm by the action of sunlight. The chlorophyll exists as minute grains embedded in the otherwise colourless protoplasmic substance, and it is this which makes the world so green. It is present in all leaves and in young leaf stalks—even in red or yellow or variegated leaves; though in such leaves it may have undergone some change, or else the green colour may be overlaid and hidden by other colouring matters dissolved in the cell-sap. Chloro-

phyll there must be, or the plant cannot make use of the carbon-dioxide which the leaves take from the atmosphere and convert into sugar and starch. I will try to tell you more about the chlorophyll in a later chapter.

Moisture, air, light, warmth and food are all necessary to the growth of plants. The cells cannot increase and multiply without warmth, for the protoplasm is easily killed by cold, while it is most active in warm temperatures. You know how plants go to rest at the approach of winter, when the soil becomes cold. If the soil is frozen, then no plant growth can take place, because the roots cannot absorb the water needed to make and nourish the cells. Plant roots take in astonishing quantities of water. The chemicals in the soil form the plant's main food supply, and these chemicals cannot be assimilated unless they are very highly diluted. A plant cannot make use of strong doses of the nitrogen, potash, phosphorus and other elements it derives from the soil, and consequently it must absorb a great deal of water in order to get enough of these things. As all plant tissues are mostly water, and are partly built up of the oxygen and hydrogen existing in the water, it is certain that ample supplies of fluid must be available in the soil for converting into cells. But a great deal of the water taken in by the roots is passed on to the air again, after the leaves have taken out the chemicals it contained. This is a process like perspiration, only in plants it is called *transpiration*.

The water is given off in the form of vapour, and its passage is controlled by special organs on the underside of the leaves, about which I will tell you more in another chapter. A single cabbage plant gives off about a pint of water in a day, if the day is sunny. Perhaps that doesn't sound a great deal, but it is really a nice long drink. The amount of water vapour transpired by plants sounds more

impressive when we come to measure it by the acre; an acre of sunflowers, for example, gives off more than a thousand tons of water during the six months or so of its growth; and a large tree takes out of the soil, and gives back to the air, several hundred pounds of water during a hot summer's day.

The way in which plants take in water and pass it on, from cell to cell, throughout the whole of their structures, is one of the most astonishing things in natural history. The great elm at the corner of the road is supplying its myriad leaves with water, even those high above the earth, eighty feet up. There is a pump in your body to keep the vital fluid circulating, but plants have no such pump. Yet the water must be taken from the minute cavities between the grains of soil, where microscopically-fine feeding roots search for and absorb it: it must be distributed upwards and outwards to every leaf and shoot and bud against the force of gravity. How does the water move without a pump?

That is a very difficult riddle to answer. But it is such an interesting riddle that it is well worth while trying to get upsides with a real botany book for the sake of the answer. Of course, the plant—whether it be a forest tree or a tiny grass—must itself provide the power necessary to lift the water out of the earth; nothing can be lifted or moved anyhow without an expenditure of energy. So all those leaves so high up in the tree-top must be hard at work raising water, just as you would have to work to haul water out of a well.

The work of lifting the water begins at the roots, as we should expect. A peculiarity of cellular tissue is that water can pass through it under certain conditions. A cell wall is porous to fluids *when there is a difference in the density of the fluids* inside and outside it. We cannot go into details

here, but I think you may be able to understand that the chemical changes going on inside the cells—the movement of the protoplasm and its adaptation to the making of different kinds of cell-tissues—is one cause of the difference in the density of cell-fluids. The cells of the root-hairs absorb water from the cavities between the grains of soil, and also the chemicals dissolved in that water; and the cells abutting on those having the root-hairs absorb the fluid from the latter, because the fluid they contain is slightly different in density. The adjoining cells next absorb the fluid, and so on in succession, so that a current of sap is being *pushed* up into the plant. This is known as "root pressure". Eventually, the sap reaches the leaves, cell by cell, and then the leaves take a hand in the work. Their transpiration—the passing out of water, in vapour form, to the atmosphere—is a process of evaporation; it involves a difference of pressure inside and outside the cell-walls, which further assists the marvellous circulation of the sap.

CHAPTER VI

Leaves and their Uses

When we speak of "the green earth" or allude in any way to the verdure of plant life, we are speaking of leaves. The general effect of vegetation as seen in a landscape is produced entirely by leaves. It is the leaves of grass which make an emerald meadow, the leaves of trees which make a bosky wood, the leaves of laurels and kindred plants which make a darkling shrubbery. But the plant does not grow leaves for artistic effect. They are an active part of the factory which converts chemical substances into vegetable matter.

Leaves are developments of the stem. In their early days they appear as tiny buds clustered at the tip of the stem. Some plants do not throw out a leaf stem, and in such cases the leaves open close to the ground, forming a rosette round the flower stalk. These are called *radical* leaves, and you can think of many plants which grow in this manner—all the dandelion family, the plantain, the primrose, the daisy and numerous friends in the flower garden, such as sempervivums and saxifrages. But it more generally happens that the stem grows, increasing the space between the leaf buds. You will notice that the oldest leaves are *always* nearest to the root, and that as the stem grows the newest leaves are always those near the growing tip. The point at which leaves spring from the stem is

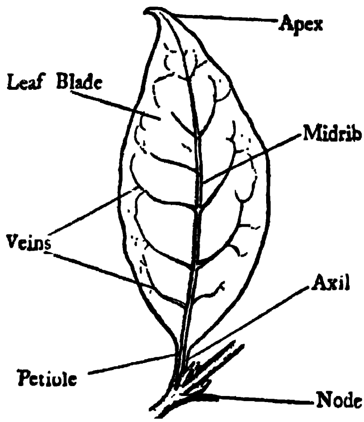


Diagram of a privet leaf showing the parts

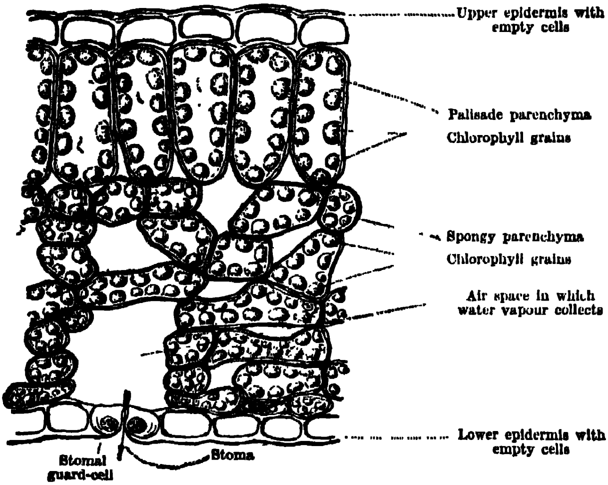
called a *node*; the portion of stem between the nodes is an *internode.* Between the leaf, or leaf-stalk, where one is present, and the stem, is the *axil.* Most plants develop at the axils buds which grow into lateral shoots.

The structure of the leaf is built up of tissues similar to those of the stem (Chapter V), the vascular bundles showing in the leaf as veins. In all the plants called dicotyledons, the veins branch and rebranch, making those wonderful patterns which we sometimes find in skeleton leaves when all the soft tissue has died away and only the harder veins remain. The soft tissue contains the apparatus for breathing. In the leaves are little openings called *stomata.*[1] By means of the stomata the plant inhales oxygen and carbon dioxide, and exhales oxygen, having kept the carbon for its nutrition. The plant also transpires through the stomata.

Each little " mouth " or *stoma* is a minute slit which opens on to a space between the cells in the underlying tissue of the leaf. Like real mouths, the stomata open and shut. At each side of the slit is a sickle-shaped cell, called a guard cell, which moves under the influence of light; that is to say, it alters its shape. In daylight the guard cells become more curved—more sickle-shaped—thus forming the opening of the stoma they guard. In darkness, they straighten out, closing up the opening.

The wise gardener takes advantage of this power of the

[1] Greek, *stoma*, the mouth.



Diagrammatic section of a leaf

stomata to close, when he has to transplant evergreen trees and shrubs. They are much more difficult to transplant successfully than *deciduous* plants—those which drop their leaves naturally in winter—and you can see why this is so. A deciduous tree—a fruit tree, for example—is transplanted at a time of year when it is sleeping; its roots are inactive and it has no leaves. But there is never a time when evergreens have no leaves, and when a plant of this kind has to be moved from one place to another it is necessary to prevent transpiration, or the leaves would lose water more quickly than the damaged roots could send the sap up to them, and the plant would die. Therefore we ought not to transplant evergreens in the winter, but rather as late as possible in the spring, or very early in the autumn when the soil is warm enough for the roots to grow again. Further, we must stop transpiration by causing the stomata to close. This we do by shading the plants so that they cannot get much light, and we syringe them frequently to stop evapo-

ration. If that isn't enough, and the newly-transplanted evergreen looks unhappy and droops its leaves, we may still save its life by removing most of the leaves—a drastic, but often effectual method of stopping the disorganized sap-circulation.

Not only do the stomata " shut up " at night; they also close when the soil becomes too dry to supply the roots with the water they seek. The leaves droop and thus reduce the area they normally expose to the light. If you water a flagging plant (before the flagging has gone too far) it will pick up again before your eyes; the limp leaves will recover their stiffness and their normal positions, showing you how quickly water is passed to all parts of the plant.

In very hot, dry countries, and also in countries where the winds are intensely cold, instead of intensely hot, it is necessary to slow down transpiration. The plants native to such regions have developed wonderful adaptations of their leaves for meeting the necessity. The leaves are often coated with wax or resin, giving the plant a peculiar " unnatural " look. The leaves, too, are often very small, and greyish or brownish instead of green, on account of the waxy coating; or, if they are large, there are so few of them that the tree or shrub has a sparse and hungry look. Indeed, a trained gardener can generally make a pretty shrewd guess at the sort of climate natural to a particular tree or shrub, just by looking at its leaves.

There is one form of leaf, specially adapted to restrict transpiration, with which you are quite familiar. That is the pine needle. It is so narrow that it offers very little surface to the drying influence of the wind. Indeed, pine trees only transpire about a fifth as much moisture as leafy trees of the same size, like oaks and elms. And not only is the shape of pine needles adapted to conserve moisture

they are often provided with some of the devices we have already noticed. The needles of some varieties are gummy or resinous, and the colour is a bluish green which gives the trees a beautiful silvery look. The cone-bearing trees—pines, firs, larches and spruces, cedars and cypresses, have either needle-like leaves or very small, scale-like leaves. So, too, have yews and junipers, which, though they do not bear cones, are gymnosperms or " naked-seed " plants, like the conifers.

In very dry climates leaves that are not needle-like in shape have a habit of hanging at right angles to the sun, so that they present only a thin edge to the full strength of his rays. It is this which has given rise to the phrase " the shadowless trees of Australia ", because there the leaves of eucalyptus and gum hang with their narrowest sides towards the sun, and only stir and show their shape when he begins to decline. Even grasses fold their blades inwards in order to expose the least possible area of their surface to the sun.

I told you, a page or two back, that one function of the minute leaf pores called stomata was that of breathing or *respiration.* Plants, like animals, cannot live without air. Just as we do, they take in oxygen from the air to maintain the energy of the living tissues. A complicated process of internal combustion goes on wherever protoplasm is being changed into the substances of which cells are made. One of the products of the change is carbon dioxide, which, with heat, always results from *burning* anything. All life really depends on a very slow sort of combustion, as I dare say you know. But the leaves are not only engaged in respiration—the breathing in of oxygen, and the breathing out of the products of combustion, carbonic acid. They have other work to do in helping to build up the food-reserves of the plant—sugar and starch. Sugar and starch

are organic [1] compounds of carbon, oxygen and hydrogen. One-half of the solid substance of plants is formed of carbon. All this is taken in by the leaves, which also carry out the process of converting the carbon into sugar and starch. The nutriment thus formed passes to other parts of the plant, some to be used in growth and some to be stored away in tubers, roots and seeds. The plant always has to look ahead and make reserves of food for its own use during the winter, or for its children's use in the next year.

This process is called *assimilation.* To carry it on, the leaves perform a process which is almost exactly the reverse of the breathing or respiration process. In breathing, the leaves take in oxygen and exhale carbonic acid; in feeding or assimilation they are taking in carbonic acid and exhaling oxygen. Which seems odd and contradictory, until you remember that the breathing is necessary to the breaking down, or " burning up ", of starch; while assimilation is just the opposite, and leads to the *building up* of starch.

You have only to think of your bread and jam, pudding and potatoes, to realize how immensely important this process of carbon-making by the leaves is to all of us. To get an idea of how the process is carried on, we must go back to the chlorophyll grains I mentioned in the last chapter. They are very tiny green bodies within the protoplasm of the parenchyma cells, and we may liken them to an immense number of engines in a starch factory. The power which drives the factory is the energy of sunlight. The carbon dioxide of the air passes through the self-acting valves of the stomata, into the little spaces between the parenchyma cells. The radiant energy of the sunlight,

[1] Organic substances are those formed by the work of living cells. *Inorganic* substances are those which exist independently of life, such as iron, oxygen, hydrogen, and the other chemical elements.

acting upon the chlorophyll, sets it to work to combine the carbon dioxide with the hydrogen and oxygen already present in the water of the cells, to make sugar. To obtain enough carbon and hydrogen from the carbon dioxide and the water of the cell-sap, the factory has to deal with a surplus of oxygen. This is given up to the atmosphere, through the stomata, so enriching it for the benefit of animals.

As the light and the chlorophyll together manufacture the sugar, it becomes changed into little specks of starch, which are stored in the leaf cells, to be presently handed over to the other parts of the plant which require them. The transportation of the starch takes place at night, when the sugar factory has stopped working. Now, there is a very odd thing about the method of transporting the starch grains from the leaf cells in which they were formed; the starch must be changed again to sugar before it can be moved. The reason is that starch is insoluble in water, and so could not pass through the cell walls, that clearly being the only way in which it can be moved to the other parts of the plant. So it changes again to sugar which is soluble, passes from cell to cell, and finally comes again to starch in the parts of the plant where it is most wanted.

Many plants have a pretty habit of folding their leaves at night. We may notice this particularly in the lupin and wood sorrel. The leaves fold and droop, lying near to the stem, and have a sleepy, shut-up appearance. Yet the plants are not asleep, and this folding of the leaves has nothing to do with repose. It is yet another effort to reduce transpiration through the cold hours of the night, by reducing the area of leaf surface exposed to the wind. It is also a means of conserving warmth in what may be called the "body" of the plant. This leaf movement is brought about by changes in the cells, which become limp as darkness

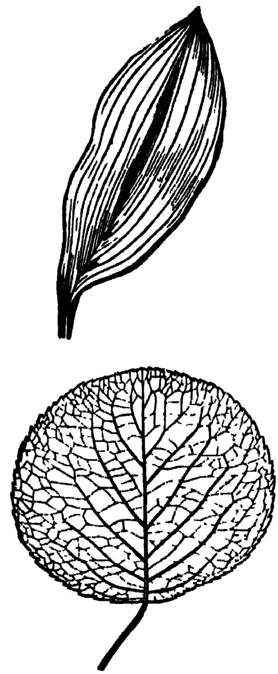
Leaves arranged so that they can get as much light as possible

approaches. When light is restored, the cells regain their stiffness, and the stalks stand to attention once more.

Doubtless you have often wondered at the immense variety of leaf forms. Many of them are extremely beautiful, and generation after generation of painters and sculptors have copied the shapes of certain leaves as the most pleasing designs they could find. But once more we must remember that Nature does not work *primarily* for our admiration. Though leaves are indeed beautiful, their shapes are the outcome of particular plant needs in the struggle for survival, and we should never cease to marvel at the power of adaptation that has brought into being the forms that please us. The deeply cut and divided leaves that are such an attractive feature of many plants have adopted such shapes so as to enable a great number of leaves to act as starch factories without shutting off the motive power from one another. Leaves must have light, and a heavy solid shape would obscure light, whereas a system of long, narrow leaflets, or of lacy, fern-like leaves, makes only the lightest of

shadows. Leaves—and the branches that bear them—are always arranged in such a way that they can obtain as much light as possible.

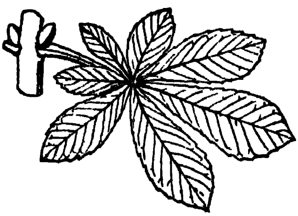
The grass-shaped leaves, long, narrow and having *parallel* veins, all belong to the monocotyledons. All the bulbous plants have such leaves, as well as grasses and rushes. All other plants are *net*-veined. A net-veined leaf may be *simple*, all in one piece like a violet leaf; or *compound*, divided into leaflets. There are several kinds of compound leaves, classified according to the form in which the leaflets are arranged. In the horse chestnut they all spring from the same place, and may be five or seven in number. In the clover and strawberry families the leaflets are only three, springing from the same place. The leaflets of the rose are arranged at the tip and at each side of a midrib. Sometimes it is rather difficult to tell whether you are looking at a whole leaf or the leaflet of a compound leaf. That can be settled by reference to the axils. Leaflets never have buds at their axils with the midrib.



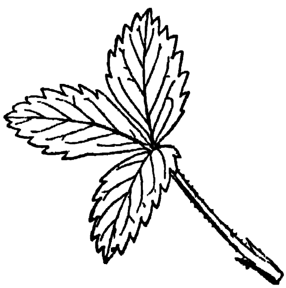
Parallel and net-veined leaves

The margin of a leaf has its place in identification, as the shapes of leaves are often much alike. Special names have been given to these margins, which may be described as smooth, saw-like, coarsely-toothed, with rounded teeth, hairy, wavy. You can easily fill in half an hour by finding leaves whose edges fit these descriptions.

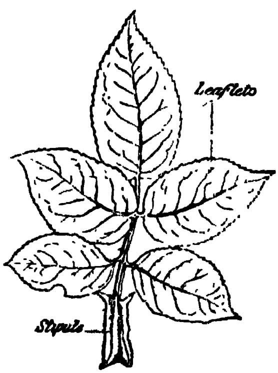
Nature has been very clever in devising ways of pro-



Palmate leaf of Horse Chestnut



Ternate leaf of Strawberry



Pinnate leaf of Rose

Compound leaves

tecting her children, and for their protection she provides certain leaves with stinging hairs. Others develop prickles and spines which keep enemies at a distance, and some secure safety by secreting poisons. Look at that tall holly tree growing in the hedge by the pasture. The dark glossy lower leaves are armoured with curved sharp spikes, and no creature dares to take a mouthful. Only the urge of Christmas wreaths will tempt any of us to cut the branches. But up above, where the tree rears its head safely out of the reach of any English animal, the leaves are smooth and kind. Hawthorn and sloe make good hedges because their thorns protect them from the attacks of cattle, and only the tender tips of gorse are eaten: the older branches being too sharp to be tackled.

Plants, as we see, grow leaves because they are a necessity; so much so that if a plant loses its leaves by the attacks of insects it cannot survive. But to man, the leaves have other significances. The gardener grows " foliage plants " for the sake of the beauty of the shape and colouring of the leaves. Or he grows asparagus fern and smilax in his green-

house for decorating the dinner-table. The florist grows maidenhair fern for making wreaths and bouquets. In very much greater degree plants are grown for the edible qualities of their leaves. Cabbage leaves and lettuce leaves cover hundreds of thousands of acres, and form an essential part of the nation's food. The most important leaf of all is grass. Grown either for pasture or for hay, it makes the world's milk and beef and mutton, and helps to support its horses.

There is another leaf which is of great economic importance, and that is the tea leaf. British people drink about 1,500,000 lb. of tea *a day*, and a vast number of tiny leaves must go to the making of that amount. Other nations, particularly Russians and Chinese, are even heavier tea drinkers. The cultivation of tea originated in China, where it has been drunk for thousands of years. It is a beautiful shrub with shining dark green leaves. Of these only the newest—that is to say, the two at the end of a shoot, and the growing tip between them—are picked for drying. Tea was introduced into India from China, and there is also an indigenous Indian or native tea-plant which was first found growing wild in Assam. Not more than seventy years ago practically all our supplies of tea came from China, but with the discovery of the wild tea-plant of Assam the Indian tea trade made rapid progress, with the result that we now import about 150,000 tons of tea annually from India, and only about 2300 tons from China. The tea-plant requires lavish supplies of water at regular seasons, but does not trouble much about its locality. In fact, tea grown in Ceylon at an altitude of 7000 feet has a more delicate flavour than that grown at a lower level. Tea, however, seems to be a product of the Old World, for the Americas do not grow tea commercially. In South America tea is supplanted by maté,

a tree of the holly family, of which the dried leaves make a refreshing and stimulating drink.

Lastly, we must mention the leaf which is, perhaps, even more highly desired than the tea leaf—the tobacco leaf. Until recent years this was regarded as entirely a plant of the sub-tropical and tropical zone, but it is now being grown successfully in England and Ireland. Apart from questions of climate, it is a difficult crop to grow well because the leaves absorb the mineral constituents of the soil and the taste and burning properties of the manufactured tobacco are affected thereby. For instance, salt may be used as a fertilizer, in which case the leaves will be stored with chlorine and will refuse to burn. If lime is used, the leaves will be large and luxurious but deficient in flavour, while new soil tends to grow coarse leaves with an acrid taste. The best land for tobacco is a sandy soil that has been long under cultivation. While the young plants are growing they are peculiarly subject to insect pests and the grower does not trust to his own eyes to watch for these. He imports flocks of turkeys, which, wandering freely in the plantation, do no harm to the seedlings, but make short work of the insects. In some districts where rapid changes of temperature, dangerous to seedlings, may occur, the young plants are raised under vast tents of cheesecloth, which give the country the appearance of having been subject to local snowstorms of great severity.

CHAPTER VII

Pulling Flowers to Pieces

Go into the garden and pick a few flowers. Pick a handful, if you like—all the sorts you can find; not the best ones, or you'll certainly get into trouble, but a blossom here and there won't be missed. You'll do not a fraction of the harm that birds, animals, insects, rain, wind, microbes, heat, cold and human carelessness do in the garden every day, and you will hold in your hands something which human beings are seeking the world over: you will hold some part of the secret of beauty. And you don't need to pick the largest, gayest, showiest flowers to get at the coveted thing we are all looking for. Groundsel, chickweed, buttercup and daisy will do just as well, even though they are less satisfying to the eye.

This *something* is perfection of form and function, which the despised groundsel and chickweed, the dock and the dandelion, typify just as well as, and even a little better than, the grander flowers of the gardener and the florist. Mind you, the garden flowers are of far greater value and importance to us than the " weeds "; but if ever you come to botanize seriously you will know the beauty that hides in a humble, insignificant flower just because it is perfectly adapted to its needs.

When I was very small I was told to learn a piece of poetry, beginning, as far as I remember,

God might have made the earth bring forth
  Enough for great and small,
For food, for medicine and seed
  Without a flower at all.

I say " told to learn " advisedly, because it seemed to me to be a very silly piece of poetry and not worth the trouble of learning. For how, I asked myself, could God, with power to create flowers, refrain from creating things so lovely? Of course He might have made the earth bring forth without a flower at all, but then—what a large measure of joy would have been denied us!

I have told you how all the parts of the plant are composed of millions of tiny cells, containing (or having contained) the wonderful life-substance, protoplasm; and how the cells become changed or *modified* to fulfil the particular needs of different organs. Some of the cells become woody fibres, some become bark, some become root hairs, others leaf- or stem-hairs, others again form the minute pores which secrete scents, nice or nasty, and so on throughout the plant. Specialization of this kind goes on in all living things—a division of labour to ensure that all the vital functions of the organism are fairly and properly attended to. Though the same cell substance is modified in this remarkable way to perform quite different duties, the organs so formed cannot afterwards change their function. You can easily see this for yourself by sprouting large seeds, such as peas or beans, in a saucer of wet blotting-paper. The seeds, we know, contain two little buds; the radicle, which grows downwards to make a root, and the plumule, which grows upwards to make a stem. Now, radicle and plumule can never change their functions. You can grow your seeds upside down so that the radicle is uppermost; you can make it as difficult as you like for the root and the

shoot to maintain their natural positions; but nothing you do will alter their ordained functions. So long as you leave them any power of growth, the plumule will *always* try to grow upwards, towards the light, and the radicle will *always* try to grow downwards, away from the light.

During the early stages of a plant's life—in its childhood, that is—all its energies are devoted to building up a strong framework and a vigorous breathing and feeding system. But when roots, branches and leaves are sufficiently developed a change comes to some of the cells, and they are modified so that they become organs of reproduction. Instead of making leaf-buds they make flower-buds. The length of time a plant takes to reach this stage from the germination of the seed may be a very rapid or a very slow business. Goundsel, chickweed, love-in-a-mist, godetia and hundreds of other garden flowers, good and bad, and grasses like wheat, barley, oats and Indian corn, all grow flowers, scatter their seeds and die within a year. Their lives only last a few months; such are called *annuals*. Others, Sweet William and Canterbury Bells, for example, flower the year following germination, and then die; these are *biennials*. But most flowering plants are *perennials*. They go on living, and generally flowering, year after year, taking a rest each year after they have flowered. Even these vary greatly in the time they take to reach the flowering stage. Some flower when they are only a few weeks old. The big trees take years to " grow up ", and the agave of Central America is called the Century Plant, because it does not flower until it is eighty or a hundred years old.

The agave is an extremely interesting plant in many ways, but particularly because it shows us how the development of leaf-buds into flower-buds may be delayed in the case of a plant which has such an easy existence that there is no

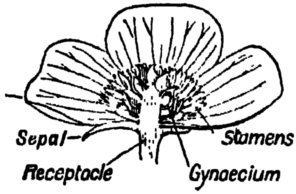
The Agave

urgent need for it to reproduce itself. It is as though Nature whispered to one tribe of plants: " Be quick and rear your young! The world is full of enemies waiting to devour you;" and to another: " No need to hurry. Your hold is secure." It is only in the peaceful security of hothouses that the agave is so leisurely in providing a new generation. In its native haunts, where the risks are much higher, it flowers, not at the age of eighty or a hundred, but at eight or ten. In the garden, too, where plants are protected, you may see this reluctance to tackle the serious business of a plant's life—the business of producing children. The gardener sometimes has to adopt drastic measures to induce fruitful-

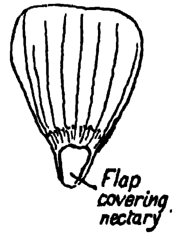
1, Buttercup seen from behind, showing sepals. 2, The same with sepals removed. 3, The five sepals. 4, The five petals. 5, The flower seen from in front. 6, The pistil. 7, Sepals and petals removed. 8, Seed-cases and a single seed cut open. 9, Stamens with pistil removed.

ness in lazy fruit trees that refuse to modify leaf-buds into flower-buds.

When we talk of a flower we are generally thinking of the decorative part of the plant—the petals or sometimes petals and sepals, or rays and discs. This decorative part, however, is only a means to an end, and that is where we are forced to agree with the writer of the little poem I quoted. For the floral organs, which carry on the reproductive work of the plant, are hidden away and add nothing to external beauty, and we must admit that their functions



Section of a buttercup



Single petal, showing the pouch-like nectary

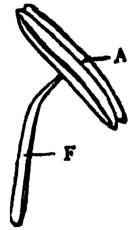
might have been so arranged that no signals such as brightly-coloured petals would be necessary to their usefulness.

Now, from the bunch you picked, let us take a single flower and pull it to pieces. Only in that way can we learn how it is put together. We can find out a great deal by pulling different sorts of flowers to pieces, not in a half-hearted, haphazard kind of way, but by giving our minds to the job. Very soon we shall discover that though they look very different from one another all flowers are really very much alike, in spite of infinite variation of detail.

Here I must warn you that in the next few pages you will come across unfamiliar words that may scare you. You won't get the hang of them at the first trial, nor even the second. The thing to do is to take this chapter in several doses, and to pull a different flower to pieces until the terms and their meanings make easy reading.

Let us start with a buttercup and examine it in some detail. The brightly-coloured petals, five of them, form the *corolla*, which is inclosed in a small green cup of five sepals. This cup is the *calyx*. In some plants there is no difference in colour between the corolla and the calyx; the two parts are then spoken of together as the *perianth*. They are there in order to call attention to the vital organs within; or we may put it that they are signs read by insects as

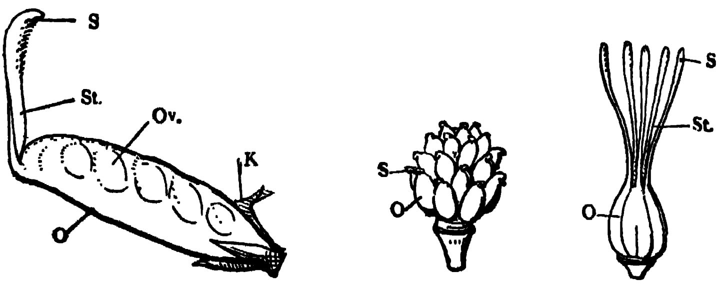
" Honey may be obtained here ". There is a nasty thing to learn about the corolla, and that is that when the petals are separate it is called *polypetalous*, and when they are united it is *gamopetalous*. This unpleasant piece of information will prove useful when we come to the classification of flowers.



A Stamen. A, Anther. F, Filament.

Within the corolla are rings of stamens, called collectively the *andrœcium*. Each stamen is made up of a stalk, the filament — and a head—the anther. The anther contains pollen. In the centre of the andrœcium is the pistil, which is composed of carpels—small chambers containing ovules. The group of carpels is called collectively the ovary. In the buttercup the pistil is made up of several carpels, free from one another, and is called an *apocarpous* pistil. If the carpels are joined together, or combined to form a single ovary, the pistil is *syncarpous*. The apex of the carpel is lengthened into a little stalk, called the style, terminating in a thickened knob called the stigma.

Another name for the pistil is the *gynœceum*, and when we have looked up the derivation of the two words an-



1, Pea, simplest type of pistil consisting of one carpel. 2, Apocarpous pistil as in buttercup. 3, Syncarpous pistil—the carpels have combined to form one ovary. K, Calyx. O, Ovary. Ov, Ovules. S, Stigma. St, Style.

drœcium and gynœceum [1] we shall understand the uses of the floral organs more clearly. The andrœcium is the male part of the plant and the gynœceum is the female; or to put it more simply, the stamens are the fathers of the numerous seeds borne by the pistil.

These parts of the flower and the functions they serve are so important to our understanding of the secrets of plant life, that it is well worth making an effort to get them firmly fixed in our memories. Whenever we examine a flower, we find these essential organs. Sometimes petals or sepals are so tiny that they are barely recognizable; sometimes, but very rarely, we cannot find petals and sepals because they are entirely absent. But we can *always* find male organs or andrœcium—the stamens which produce the pollen—and the female organ or gynœceum—the pistil by means of which the pollen reaches the germ cells in the ovules or little eggs which turn into the seeds. We went over some of this ground in Chapter II, but it won't hurt us to refresh our memories.[2]

The seed is made in this manner. The ovules are formed inside the carpels, but by themselves they can do nothing. Before they can develop they must be fertilized, by the process called pollination. Some plants can do this for themselves and are described as being self-fertile, but others cannot do so, but depend upon cross-fertilization; that is pollination by another flower of the same species. Pollination simply means the contact between the stigma and some pollen from the anther. The buttercup which we are studying is self-fertile and the pollen grains fall easily upon the stigma. A pollen grain is composed of dense protoplasm

[1] *Andrœcium* (and-rē-sē-um) is Greek for "man's house"; *gynœceum* (jin-ē-sē-um), "woman's house".

[2] It was in this chapter that we learnt that in some species of plants the sexes exist as separate individuals.

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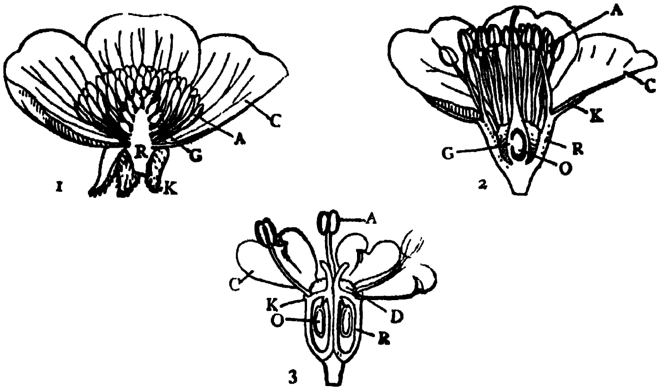
A BANANA TREE IN FLOWER

Showing the blood-red blossom drooping from a thick stem about 5 ft. long, on which farther up bunches of bananas are seen growing. Photograph by Mr. August Bok.



1, Section of hypogynous flower (buttercup). 2, Section of perigynous flower (cherry). 3, Section of epigynous flower (apple). R, Receptacle. K, Calyx. C, Corolla. A, Andrœcium. G, Gynœceum. D, Disc. O, Ovule.

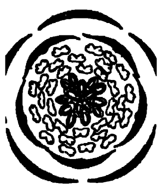
enriched by oil and starch. It is covered with an oily substance by means of which it sticks to the bodies of insects which visit the flower, and sooner or later it is rubbed off on to the stigma. In a self-fertile plant the pollen may reach the stigma without the help of an insect.

When it is firmly fixed in the stigma, the pollen grain begins to grow; that is to say, it sends out a thread-like tube which finds its way down the style right into the carpel and unites with the ovule. When that happens great activity arises in the cells, which begin to multiply rapidly, forming ultimately the *embryo*. When the seed is fully formed, which is another way of saying that the fruit is ripe, it is allowed to leave the parent by one of a number of ways. In our buttercup the seed vessel is called an *achene*; it is like a tiny dry nut. The achene splits open and the seed flies out. Strawberries carry their seeds outside them, the pea family always make pods, dandelions and thistles prefer " clocks ", so that the children may float away, while ash trees and sycamore trees favour wings.

Now let us see how our buttercup is united to its stalk.

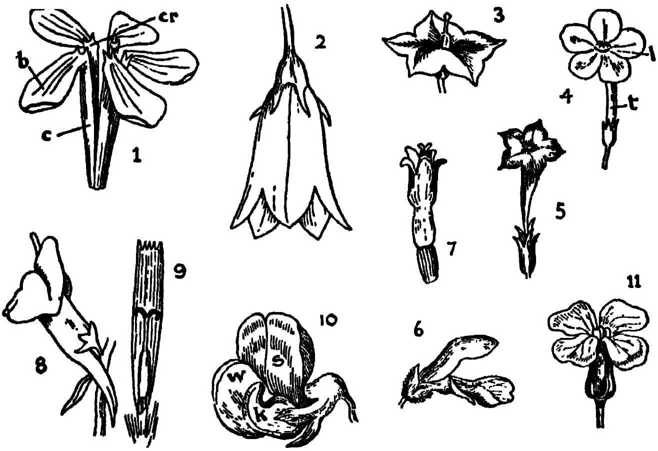
The top of the stalk is called the *receptacle.* The flower, of course, is simply a development of the stalk. In the buttercup the receptacle is cone-shaped, that is to say, the carpels are a continuation of the stalk and the stamens, petals, and sepals are carried on three lower levels. For this reason the stamens and petals are called *hypogynous* (below the gynœceum) and the sepals are *inferior.* In some plants the receptacle is cup-shaped, so that the sepals, petals and stamens are in a cluster round the gynœceum. This is the case of the cherry. Its petals and stamens are *perigynous* (around the gynœceum) and its calyx inferior. A third variety is provided when the ovary is indistinguishable from the receptacle and the other organs are above it, a form which you can see well displayed in the apple. Then the corolla and the stamens are *epigynous* (above the gynœceum) and the ovary inferior.

Botanists have a very brief way of describing a flower, and a very simple way of showing the arrangement on paper, by means of a *floral diagram.* The illustration shows the floral diagram of our buttercup. The outermost ring is the calyx, or sepals, the next the corolla or petals, the third the andrœcium or stamens, and the fourth the gynœceum or carpels. Because calyx and corolla both begin with a C, it is usual to initial calyx as K. The description of the floral diagram of the buttercup is as follows: K_5, C_5, A_∞, $G_{\underline{\infty}}$. This is called the floral formula. In plain English, this would be rendered Sepals 5, Petals 5, Stamens (Andrœcium) indefinite, Carpels (Gynœcium) indefinite and superior (this indicated by the line below the number of carpels).



Floral diagram of buttercup

It is a matter needing long practice to distinguish the different flower shapes. We know already that they are polypetalous and gamopetalous, but each class is subdivided



Forms of Corollas

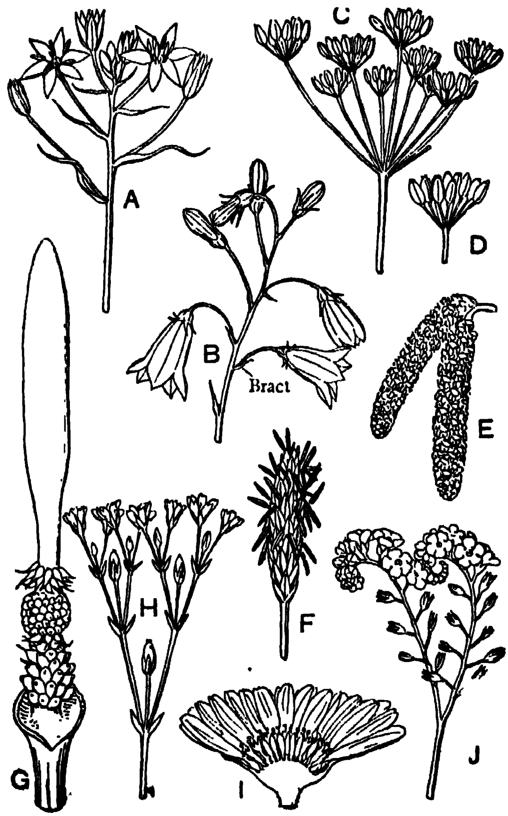
1, Polypetalous (*b*, blade; *c*, claw; *cr*, crown or corona). 2, Gamopetalous and campanulate. 3, Rotate. 4, Salver-shaped (*l*, limb; *t*, tube). 5, Funnel-shaped. 6, Labiate. 7, Tubular as in Compositæ (disc). 8, Personate and spurred at base. 9, Ligulate or strap-shaped as in Compositæ (ray). 10, Papilionaceous (*s*, standard; *w*, wing; *k*, keel). 11, Cruciform.

many times. The commonest forms of polypetalous shapes are (*a*) cruciform or cross-shape; four petals with claws, as wallflower, cabbage; (*b*) rose-shape, five petals without claws, as rose, apple, strawberry; (*c*) pink shape, five spreading petals divided almost to the base, with long claws, as pink, campion, lychnis; (*d*) butterfly shape, five petals, one much larger called the standard, overhanging the four others which together form the wings and " keel ", as pea, broom. The gamopetalous forms are tubular, bell-shaped, funnel-shaped (as in convolvulus), rotate (a short tube and spreading petal as in bugloss), and labiate, having two lips as snapdragon, dead-nettle.

It has been found convenient to name the different ways in which flowers grow upon the stalk, and these names are useful to know when you wish to describe or identify a flower. When blossoms grow singly, either at the end of stems or on short flower stalks growing from leaf axils,

they are called solitary flowers. All other arrangements are called *inflorescences*, which are subdivided into definite and indefinite. Of the definite, the most common is the *cyme*, when the main axis (i.e., the direction of growth) ends in a flower beneath which secondary stalks also end in flowers and produce still more branches (See p. 85). Other varieties of definite inflorescences are simply varieties of the cyme, such as *corymbose* cyme (flat-topped), as in the elder, and *panicled* cyme (pyramidal), as in the privet and lilac.

Indefinite inflorescences vary in a number of ways. I do not propose to burden you with the names of all of them (it does not help, for instance, to call a cowslip a *scapigerous herb*), but a few of them are useful. Flowers of the daisy family (which really demand a separate chapter to themselves) grow in what is called a *capitulum* or *involucre*. You hear people speak of the " white petals " of the daisy; but really they are not petals at all but *ray florets*, while many of the yellow organs which we too readily call stamens are *disc florets*. The ring of green bracts supporting the flower head is not a calyx but an involucre. Where flowers have no separate stalks but grow thickly on the stem, they are said to form a *spike*, e.g. plantain. A very thick fleshy stalk in which flowerets are almost embedded is a *spadix*, e.g. wild arum (the green part folded round the spadix being a *spathe*). Some plants bear male flowers in one spike and female in another; such spikes are called *catkins*, and may be seen on hazel or sallow, and many other trees in spring, as our friends of the early chapters of this book were aware. The female catkins are always the least conspicuous. Sometimes you find flowers hanging from a central stalk on stalklets of uniform length—this is a *raceme*, and if it rebranches it makes a *panicle*. But if the stalklets arising on the lower part of the stem grow tall enough to carry their flowers at



Forms of Inflorescence

A, Corymb. B, Raceme. C, Umbel (compound). D, Umbel (simple). E, Pendulous raceme, catkin. F, Spike. G, Spadix. H, Dichotomous cyme. I, Head. J, Scorpioid cyme.

the same level as the stalklets originating at the upper part of the stem, it is a *corymb*. When a short main stalk divides into stalklets of equal length, each surmounted by a flower, an *umbel* is formed, which again may redivide into a compound umbel, e.g. fool's parsley.

The result of all fertilized flowers is the seed. Some flowers, as we have seen, fertilize themselves; others depend upon cross-fertilization, generally by insects bringing pollen on their bodies from one flower and leaving a grain or two

on the stigma of another flower. Some plants bear only flowers of one sex, and then the chance of fertilization is more remote, as unless there is a plant bearing flowers of the other sex reasonably near at hand it is probable that the flowers will bloom and die sterile. Where our garden flowers are concerned we usually do not mind this, but plants that are grown for fruit must have a chance of fertilization. In many cases fruiting plants have been improved out of all recognition by the *hybridizer*. One variety has been deliberately fertilized with pollen from a different variety in order to combine the good qualities of both. All cultivated plants have been improved by such carefully-guarded crossing of selected sorts. It sometimes happens that the flowers of plants resulting from this cross-fertilization are self-sterile; the pollen has no effect in stimulating the ovules into growth. Some of our best apples and pears cannot fertilize themselves on account of this defect. They cannot produce fruit unless pollen from another apple tree (or pear tree, as the case may be) flowering at the same time, is brought to them by insects or else by the gardener's brush.

You must understand that the self-sterility just mentioned is not a case of the one-sexed flowers I spoke of earlier. These uni-sexual flowers in some species are borne on separate plants, as I told you, and people who do not know this are often sadly disappointed. They see a plant with pretty fruits, such as those borne on that beautiful shrub pernettya, and think how nice one would look in the garden. The glory of this shrub is its clusters of glossy rose-pink berries, but alas! a solitary pernettya cannot bear berries. It must have a mate of the opposite sex. Unless you plant male and female bushes of pernettya together you will have no berries at all, and, of course, they will only form on the female plant.

CHAPTER VIII

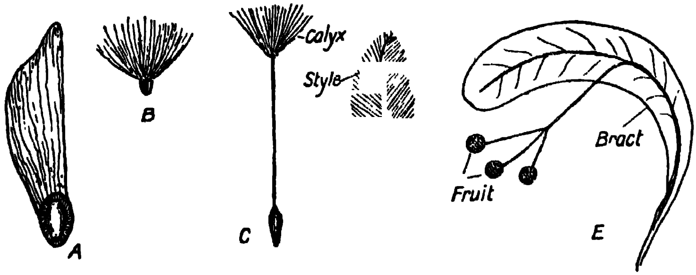
Something about Fruits and Seeds

In the last chapter we made a rapid examination of the different parts of the flower and learnt a little about seeds, but as seed-making is the whole aim and end of a plant's life the process is worthy of a more detailed study. Let us think of a few of the seeds we know: the long fine seed of grass, the round seed of the sweet pea and the laburnum—almost indistinguishable from one another; the little black seeds of the poppy, the large ridged seeds of the nasturtium, the pips of apples and pears, the stones of cherries and plums—all are cradles of new life. In each there is an embryo and a store of food which will sustain the shoot until the leaves and rootlets are strong enough to start gathering food on their own account.

Having produced a flower which has attracted the right kind of insects, and has been fertilized by them, or by the wind, the plant's next duty is to allow the seed to ripen. The flower fades now that its work has been done, and it is no longer a thing of sweet scent and brilliant colour. The petals wither and fall off, and in their place we see in formation one of the numerous forms of fruit or seed-pod. We know what has happened: the pollen tube has grown down into the ovary, and the waiting organism within has become fertile, and has started making new cells which develop into the embryo and the endosperm. The length

of time taken by this process varies in different plants, but the changes visible to the naked eye, i.e. the withering of the petals and the enlargement of the ovary, occur quite soon after pollination. Besides making the embryo and the endosperm, the cells have to be busy making them a coat; the testa or seed-coat, which covers them both and makes them into a neat little parcel. Botanically, all seeds are contained in a *fruit*, but in ordinary language we have adopted the word fruit to apply to succulent bodies containing seeds. Still more loosely do we use the word fruit to mean sweet and edible produce of the plant, maintaining that cucumbers and marrows are vegetables! A moment's reflection will show us that all these developments of the flower, including pods of beans and peas, are really fruit, although a well-known dictionary which lies beside me at this moment, airily defines "fruit" as *the produce of the earth which supplies the wants of men and animals.* The Latin origin of the word, *fructus*, to enjoy, is even vaguer still.

But Nature knew what she was doing when she devised the fruit as the cradle of new life. Her aim was twofold: to protect the new life, and to ensure that it should be carried away from the parent plant. For this double purpose she has used a variety of means. The protection is ensured by the nature of the pod or covering, which may be very hard or very spiny; or by a poisonous juice or bitter taste. Transport is sometimes effected by a wing-like shape of the seed-pod, sometimes by *pappus* (e.g. thistledown, dandelion), or by hooks which catch on to passing cattle or anything moving within reach of the plant (e.g. cleavers), and sometimes by the help of animals and birds. For instance, a bird gets into the fruit cage in the garden and pecks a strawberry. It knows that it is on dangerous ground, and swallows down its treasure as fast as it can. The in-

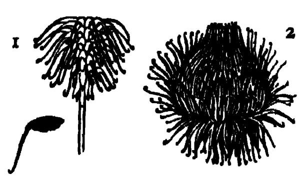


Seeds dispersed by wind

A, Winged seed of pine. B, Plumed seed of willow-herb. C, Plumed fruit of dandelion. D, Plumed fruit of clematis. E, Bract parachute of lime.

digestible seeds pass through its body and are disposed of with the droppings, probably far away from the fruit cage. Fruits which have a very hard outer casing, such as nuts of different kinds,[1] are the perquisites of squirrels, who pick the nuts before they are quite ripe and carry them away to their storehouses. Perhaps during the journey Mr. Squirrel has a fright—or a fight—and drops his nut, which rolls away into a corner; or perhaps he dies before his store is eaten up. In either case, the nutshell rots and splits open, leaving the kernel free and ready to germinate.

Now we can begin to understand something of Nature's plan. The fruits that are succulent form a natural food of animals and birds, and therefore the seeds are bound to be carried away to some new locality and set free from their coverings. If by any chance an apple, let us say, escapes the attention of men and birds and wasps, the flesh will gradually decay and the seed will still be liberated, though not at any great distance from the tree. Too thick a growth of apple trees in one place would result in all the trees being dwarfed from want of



Hooked seeds

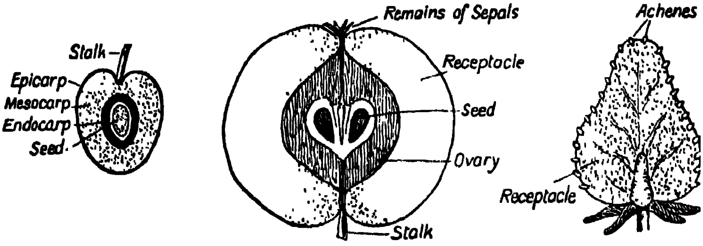
1, Geum and single seed. 2, Burdock

[1] Some nuts are described in Chapter XII.

room and want of food, and that is why there are plenty of natural carriers of the seed, as well as plenty of natural enemies of the young plants.

It is not easy at first sight to place the fruits, even those with which we are most familiar, in their appropriate classes. We may know that the apple and the hawthorn belong to the same natural order—that of the rose—but their fruits do not show much resemblance. The apple and the pear both have well-defined " cores "—the carpels in which the seeds lie. The haw contains one seed, the hip (of the rose) is full of seeds. Both these, like the apple and pear, show the withered lobes of the calyx at the end. Now the strawberry, which is of the same natural order, grows a big, fleshy fruit with the seeds sitting outside, while the raspberry and the blackberry make little collections of separate fruit of the kind called *drupes* (almonds, peaches, plums, cherries and walnuts are all drupes). These have the seed inside. So the names strawberry, raspberry, blackberry are really misnomers, for they are not berries at all. The true berries have their seeds immersed in soft pulp, such as the grape, gooseberry, currant, whortleberry, orange and banana. The banana seeds are so tiny that they are hard to find, and in any case they are no use. They are imperfectly developed and would never grow. Some plants (even those that produce fertile seeds) can increase by what is called *vegetative* reproduction. New plants grow from cuttings—shoots severed from the parent and stuck in the ground—and in some cases from leaves. The banana increases so easily from shoots that it has lost the power of forming seeds which will grow.

The fig is one of the most interesting of our edible fruits, because we do not see it in flower. The figs form, and in favourable circumstances, they swell and ripen, but we are



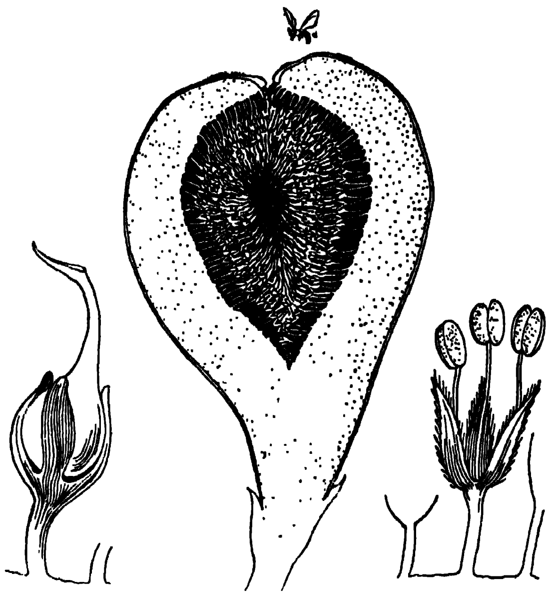
2 3

1, Section of drupe of cherry. 2, Section of pome of apple. 3, Section of false fruit of strawberry

not able to watch the flowers bud and blossom and fade. The female flowers are securely hidden *inside* the young fig, and can only be fertilized if a special kind of wasp comes along. The wasp lays its eggs in the male and female figs indiscriminately, and when the eggs hatch and the young wasps emerge some of them, of course, have pollen from male flowers on their bodies. Then they enter other figs—some containing female flowers amongst the number, and the pollen they have collected from the male flowers is caught by the stigmas of the female flowers.

Another interesting fruit is the pineapple, which does not grow on trees, as the coloured picture on the outside of a tin of pineapple chunks would have us believe. It really grows close to the ground, a cluster of tall sword-like leaves having a spike of flowers in the middle. Each one of these flowers swells out into a succulent fruit, the whole number becoming compact and consolidated into the familiar pineapple shape. The little segments on the outside of the pineapple each represent one flower, of which the *bracts*, sepals and petals have combined to form a horny outside skin. You can sometimes distinguish these separate

Section of gooseberry



In the centre is shown a section of the inflorescence of the fig. It is full of flowers. A wasp is seen approaching the entrance. On the left is a larger view of a single long-styled female flower and on the right is a male flower also enlarged

parts. From the top of the ripened fruit a tuft of green leaves appears, and this, if sliced off with the crown of the fruit, can be planted to form a new root. Cultivated pineapples rarely make seed.

Seeds which have no toothsome coverings to facilitate their transport have to adopt other means of emigration. There are seeds which cling to anything handy, a dog's coat, a man's trousers, a sack or a basket, and thus are carried far away. Seeds of this sort contribute to what is called "unintentional distribution", that is to say, the man or animal or thing which becomes the vehicle has no knowledge of the circumstance. Seeds are carried all round the world in this manner, and it accounts for many apparently mys-

terious acclimatizations of plants. It is estimated that nearly 700 fresh plants have established themselves in Central Europe in the last eighty years, by "unintentional distribution". Similarly, seeds which fall by watersides into mud may adhere to the legs and feet of wading-birds. These birds often fly immense distances and the seed travels with them. But the wind is the most frequent agent in scattering seeds, and lest he should not blow strongly enough the plants provide their fruits with wings of different sorts. The elm, ash and sycamore, for instance, have invented a filmy membrane shaped like a feather, which contains a few seeds at the base. The feather (*samara* is its proper name) catches the wind and sails gently down the breeze, coming to rest often at a considerable distance from the tree. Many flowers of the *compositæ* order furnish each fruit with a separate pappus or tuft of down. You have only to watch thistledown or groundsel down being wafted along by the lightest airs, to know how well this scheme works. Other plants have taught their fruits to explode when the fruits are ripe, the force of the explosion blowing the seeds to a surprising distance. The crackling noise you can hear coming from a gorse bush on a hot day is due to this sudden bursting of the seed-pods. Some fruits float on water, and are borne away like tiny boats to new homes. We should expect this of the water-lily, and purely aquatic or marine plants, but it is rather remarkable that the coconut, which is distinctly a land plant though liking the proximity of the sea, should be able to keep afloat over thousands of miles of ocean.

We can think of many fruits and seeds which are commercially valuable. Of course, there is a big industry concerned solely with the growing and selling of seeds *as* seeds —seeds for the flower-garden and the kitchen-garden;

Seeds scattered by explosion

1, The squirting cucumber showing one of the fruits bursting from the peduncle and forcibly ejecting its seeds. 2, Wood sorrel showing one ripe fruit ejecting its seeds. 3, An enlarged view of the ripe fruit in 2.

seeds for the farmer and the market-gardener. Then there are the fruit salesman and the big commercial enterprises of which he is a representative—orange boats, banana boats, apple boats, sailing all the seas; hundreds of square miles in the British Isles devoted to fruit growing; hundreds of thousands of square miles devoted to fruit growing in North America, Australia and South Africa; country after country in Southern Europe growing grapes and olives; and green patches innumerable in Northern Africa growing dates and figs. Mightier still, the cereals swelling and ripening all over the world, feeding mankind and his domestic animals and birds, helped by the tribes of the pea and the bean. We meet some of these fruits and seeds in Chapters XI and XII; but there are a few which are of great importance in a class by themselves.

One of these is the coffee bean. The coffee shrub is a beautiful plant bearing sprays of lovely white flowers deliciously scented. We should be delighted to have this shrub

in our gardens simply as an ornament. But when the flowers have faded they are succeeded by a fruit very much like a cherry, which ripens to a deep crimson colour. Then it is picked, and within the fruit are two greyish seeds. The use of coffee in Arabia and Abyssinia is probably older than history, and from these countries it gradually spread all over the East. It was introduced into Europe by a Dutchman in the seventeenth century, and a crop of young trees was raised in Amsterdam, whence stocks were obtained by the Paris Botanic Gardens. The French then took seedlings to their island of Martinique in the West Indies, where they flourished so abundantly that plantations were soon made throughout the West Indies. Thus coffee went round the world. But none of the newer coffees can compete in flavour with the coffees of Arabia, where the processes of coffee-gathering and drying are still carried on in the ways devised many centuries ago. The Arabians do not pick the " cherries " when they are ripe—they spread a cloth beneath the tree and allow them to fall naturally and they allow them to dry and split open without employing any artificial heat. Of course these are slower methods than those used in up-to-date coffee factories in Brazil and Kenya, but the flavour of Mocha coffee has never been surpassed by any other variety.

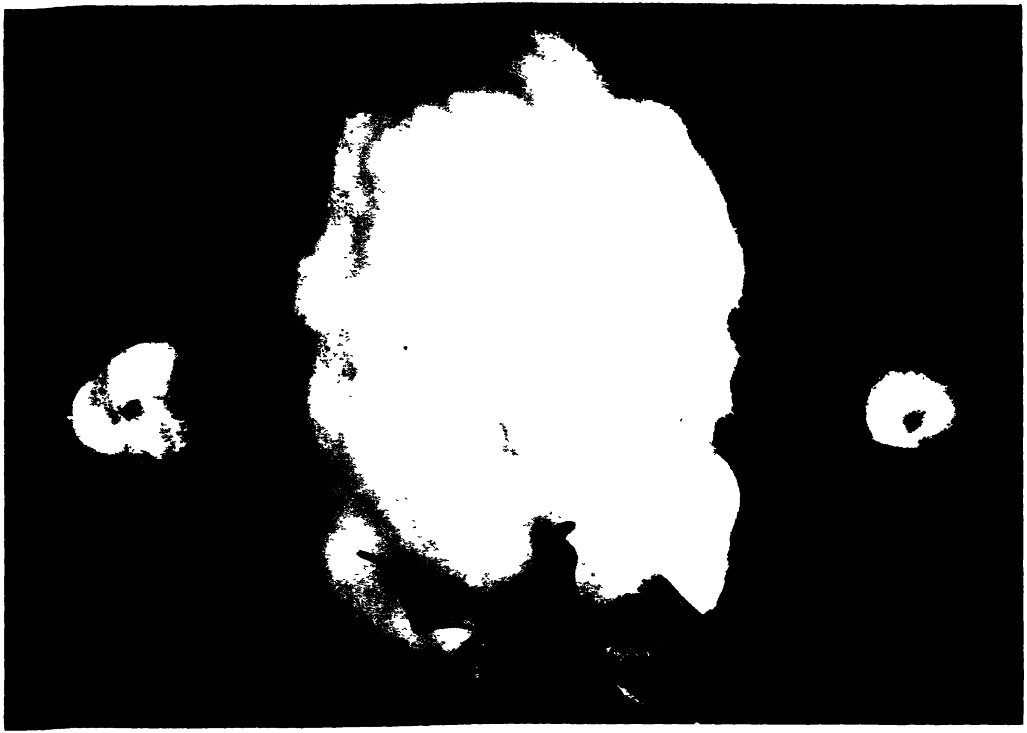
Another seed of great value is the cocoa bean. This is the fruit of the cacao tree, which was found growing in Mexico and introduced into Europe by Cortes in the sixteenth century. It is essentially a plant of the New World, but has been acclimatized in some parts of Asia and Africa. As a food, it is of exceptional value, whether taken liquid in the well-known " cup of nice hot cocoa ", or converted into a slab of chocolate, being both stimulating and sustaining.

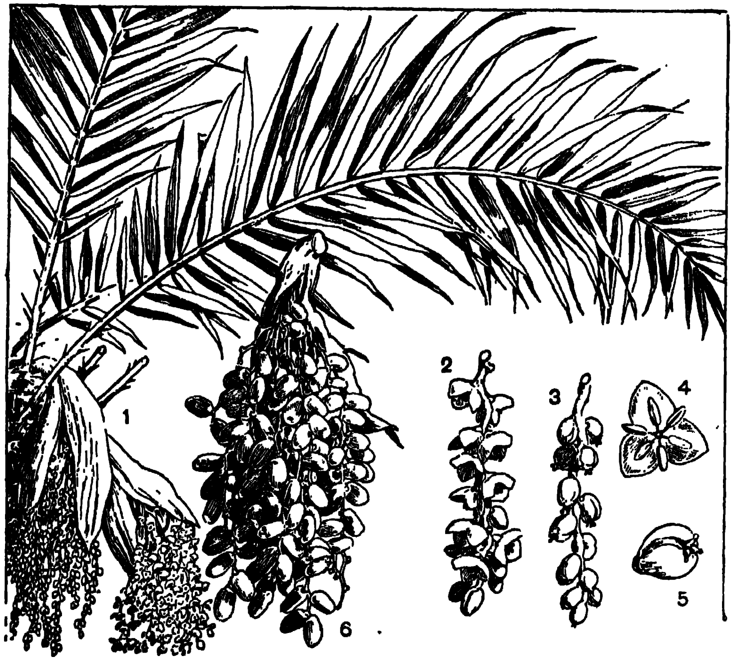
The cacao tree. One pod is opened to show the seeds. A flower is shown on the right. The flower-buds arise on the thicker branches or even on the main stem

The cacao tree grows its flowers, which are little red tufts, directly from the trunk or principal branches. These give place to pods which grow to the size of a melon, and when broken open are found to be full of seeds—the " cocoa bean ". The word bean is applied merely to indicate its size and shape, as these seeds have absolutely no connexion with any of the bean family. Cocoa needs a great deal of preparation before it is ready for the market, for it contains a large percentage of a fatty substance called cocoa butter, which is a useful commodity in itself. Cocoa for drinking is the bean ground to a very fine powder and deprived of much of the cocoa butter, whereas cocoa for making chocolate retains the fat.

COTTON POD WITH SEEDS

About two-thirds natural size. Photograph by the British Museum (Natural History).





Leaves, flowers and fruit of the date palm

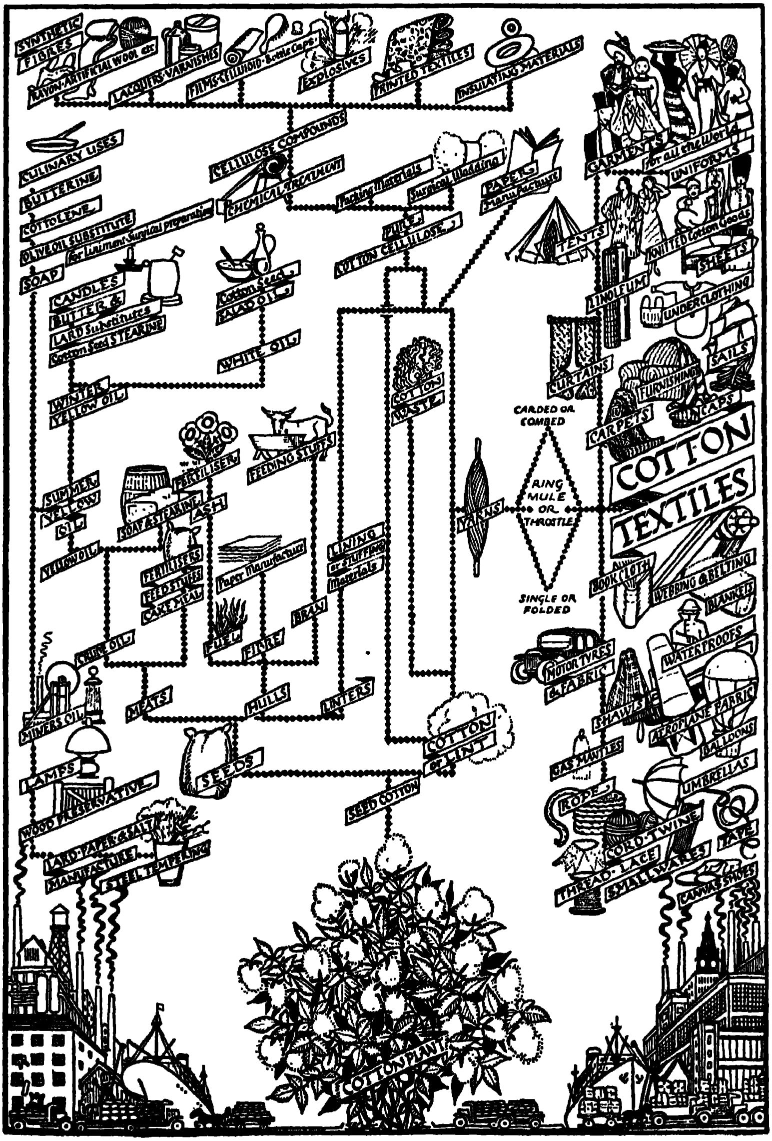
1, Leaves and inflorescences. 2, Male flowers. 3, Female flowers. 4, 5, Larger views of male and female flowers. 6, Ripe dates.

To one small class of the world's inhabitants—the dwellers in and around the Sahara—there is one fruit of supreme importance, and that is the date. Of recent years the Sahara has been explored both by motor-car and aeroplane, and its tracks and contours are fairly well known, together with its oases. But not so very long ago the only method of crossing the Sahara was by camel, on a course leading from one oasis to another, so that the travellers might not run short of provisions. To such travellers the date palm was indeed the tree of life. Nature, as always, acted with perfect wisdom when she planted the date palm on the narrow strip of productive soil surrounding an oasis. The stem of the trees

takes up little room, and at the top, twenty or thirty feet above the ground, grow the leaves, arranged in a fan, and clusters of the most nourishing fruit which can be found in the whole of the vegetable world. Smaller trees of various kinds of fruit, such as vines, apricots, peaches, pomegranates and oranges, grow amongst the slender stems of the date palms, and beneath the shade of these cereals may be grown. It is the date, however, which is of the greatest value to the traveller, because it is a compact and highly concentrated food, easy to carry, and it does not go bad after picking.

Another human necessity which can be provided by a seed is the important matter of clothing. The cotton seed is responsible for clothing nearly three-quarters of mankind, and at the same time provides an oil which is valuable as food both for man and beast, and for many other purposes. The cotton bush of commerce has been cultivated in India for more than three thousand years—the name " calico " being derived from the town of Calicut where the manufacture of cotton cloth has always centred. The tree is also native in America, where the first Spanish adventurers found the people wearing excellently dyed cotton cloth. Up to the penetration of India and America the use of cotton was little known in Europe, where the textiles were of wool and linen, and, for the rich, silk. But with the coming of cotton, a cheap, strong fabric that could be dyed and printed in coloured patterns, the more expensive materials were superseded.

Of course, Nature did not design the cotton seed for the purpose of clothing the multitude. The soft white tuft of hairs which is revealed when the fruit bursts open carries the seeds far and wide, if they are allowed to become fully ripe. But the planter steps in and gathers the seed before it is ready to leave its cradle.



THE MANY USES OF THE COTTON PLANT

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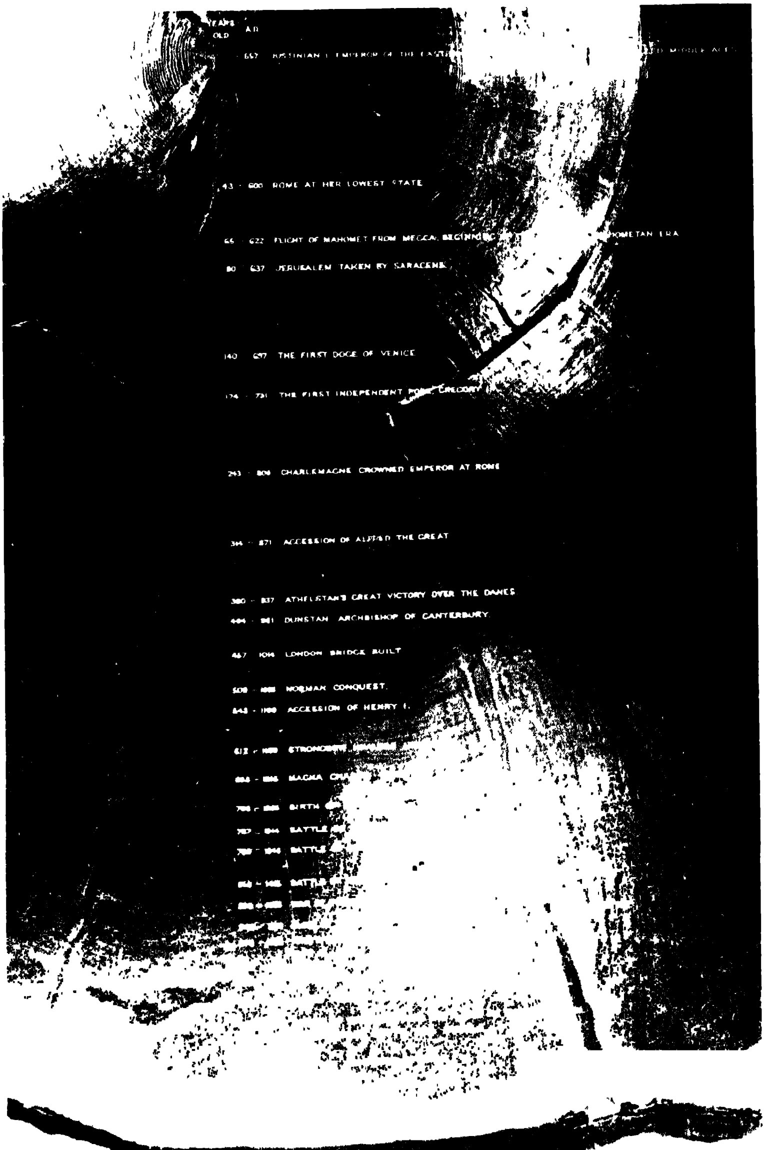
On a cotton plantation, the seed is sown in March. The young plants need careful cultivation and certain definite climatic conditions. They must have showers in May and June while they are growing, and then, when the fruit has formed after the brief flowering season, they must have strong sunshine. The pods begin to burst in September, and there is a succession of fruit generally lasting until November. The seed and lint are picked together and carried in great baskets to the "ginnery" where they are separated from one another. The rest of their story is now entirely different. The seeds go to make oil, and may finally reach the market in the form of margarine, salad oil, ointment, soap, oil for lamps and tins of sardines, or as cattle food or fertilizers. The lint is carded and spun into thread, the quality of the thread depending on the length of the fibres of the raw cotton.

Marvellous as is the story of the cotton and the machines which manufacture it, there is even more to wonder at in the effect this one commodity has had upon the world. For the sake of the cotton plantations, tens of thousands of negroes were enslaved and carried from Africa to the Southern States; for the sake of the principles involved in the slave trade the Northern and Southern States fought amongst themselves, father against son, brother against brother. For the sake of cotton Lancashire erected hundreds of spinning and weaving factories, many of which are now derelict because Japan and India have learnt how to build factories on the modern scale and to supply not only their own needs but those of many other countries as well.

This chapter is growing longer and longer, and there are still numbers of fascinating fruits to describe. Most of the spices, for instance, are fruits (not cloves, which are flower-buds). Nutmegs, which you may find in your kitchen, are



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CROSS-SECTION OF A WELLINGTONIA

Part of the cross-section about 18 ft. from the ground of a Wellingtonia (*Sequoia gigantea*) or Big Tree 276 ft. in height. The annual rings show that the tree was 1335 years old when it was cut down in 1892. The historical events occurring when certain annual rings were formed have been painted on the cross-section.

Nutmeg plant

1, Leaves and flowers. 2, Fruit split open showing the nut, surrounded by the mace, in its fleshy husk. 3, Section of a nut. 4, Section of a flower. 5, Section of a stamen and anther.

the kernels of a hard, highly-polished case, about the size of a walnut. This case is clasped by a network of a woody nature, bright red when newly picked, which you also find in the kitchen in the little tin labelled " mace ". In the tropical regions where the nutmeg grows, the fruit itself, in appearance like a golden pear, is eaten, but it is never exported, and probably is only grown commercially for the sake of the mace and the kernel.

Pepper is a berry found in most tropical countries. It may be picked when green or changing to red, and dried in the sun, when the berries shrivel and turn black, making the little wrinkled black peppercorns. White pepper is pre-

Pepper plant showing fruits (peppercorns)

pared by soaking the fruit to release the seeds, which are then ground. There are several kinds of peppers, including capsicum, from which cayenne pepper is made, and pimento. The chilli is a capsicum. All these peppery products are used in medicine as well as in cookery.

There is quite an interesting story to be told about the vanilla flavouring which is used for custards and blanc-manges. The essence of vanilla is obtained from the fruit—a long black pod—of a certain kind of orchid. This is the only orchid which produces anything of economic use; the other varieties which are cultivated being only valued for their flowers. The vanilla orchid is an uninteresting flower,

giving place to a fruit of cylindrical shape, half an inch thick and nine or ten inches long. The smell of the pod is extraordinarily powerful and persistent. If one is exposed in a warm room the scent, at first enjoyable, gradually becomes overpowering. The natural home of the vanilla orchid is tropical Asia and America, but it has been successfully acclimatized in other places and can even be ripened in English hothouses.

Vanilla plant, showing the leaves, flowers, pods and aerial roots

CHAPTER IX

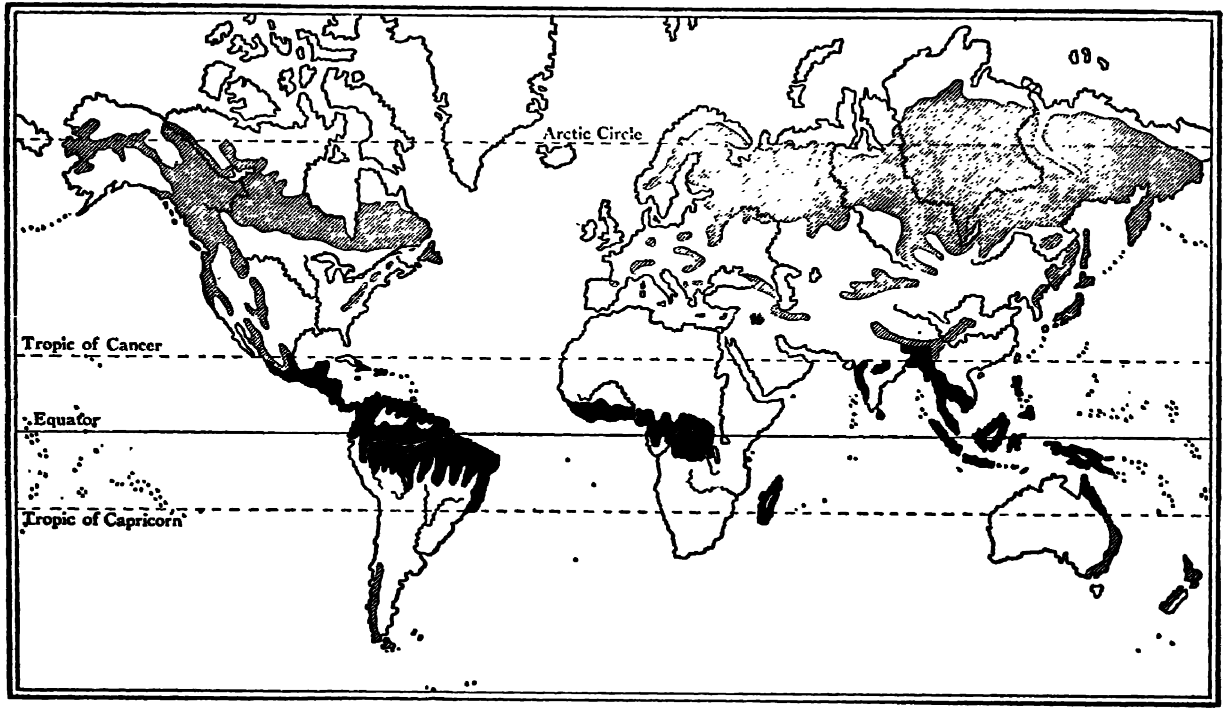
Among the Trees

The rocks make the bones of a landscape, and the trees make its characteristic features. In arable country we see long lines of elms, unmistakable from their dark green height and the flattened look they generally have owing to prudent lopping. Woods are of sturdy spreading oak, or shimmering beech; or in sandy districts or in the mountains firs and pines are abundant. The " ash grove " famed in song is a beautiful feature rarely seen. Coverts for game are of trees of lower stature making thick undergrowth, as rhododendrons, hazel and laurel. Poplars and willows abound in river meadows.

If you get away from the arterial roads and the blaring new by-passes into the real old country that still exists in Britain, where the white roads wind up and down over the moors, you will see from time to time a single pine, gnarled and hoary, or perhaps a group of three, standing sentinel where one road crosses another. This is a sign from the past, when the roads over the moor were merely tracks easily lost under a fall of snow. The pines have guided many a weary traveller who would otherwise have missed the turning leading to home and shelter. Occasionally, other vegetation has grown up and surrounded the pines, but still they stand at their corner, conspicuous in winter time, and not without their uses even now in warning motorists of " concealed turnings ".

As landmarks we must consider one of the earliest reasons for planting—or cultivating—trees. I suppose shade and protection were their virtues in the troubled eyes of the earliest of men; next, as a source of fuel; later, as a material for making weapons. When man became a hunter and took to wandering far from home the trees began their work of signposts. Up to recent times it was customary for farmers in flat, sparsely populated districts to plant Lombardy poplars as a sign of habitation. Another form of landmark is the "ring" so frequently seen on the Downs of Sussex and Wiltshire—a bold circle of trees on the flank of a down. A "hanging wood" or hangar, generally fulfils the two functions of windscreen and landmark. The planters of such trees were far-seeing, inasmuch as they planted for posterity, but they were not farseeing enough to know that their circles and ovals and oblongs of trees would one day serve as landmarks for the airman.

As, of course, you know, some kinds of trees are deciduous and some evergreen. In both kinds the functions of the leaves are the same. Deciduous trees gather nourishment during the spring and summer, and when autumn comes the tree sleeps and remains all winter in a state of suspended animation. The leaves fade and fall to the ground, where they decay and their chemical constituents pass back into the soil, to be taken up again by the roots when activity recommences in the spring. Evergreen trees retain their leaves, but in order that they may be able to withstand the cold and storms of winter their surfaces are protected in one of several ways. Sometimes the leaves are very glossy—for example, laurel and holly. The gloss is a coating of a waxy substance which prevents the leaf from losing too much moisture by evaporation. A similar protection is afforded by a covering of minute hairs which gives the leaf



MAP SHOWING THE FORESTS OF THE WORLD

Forests of tropical regions are shown in black, those of the colder lands in grey

a greyish-green or "glaucous" appearance. Yet another device of Mother Nature's for prolonging the lives of her children is to alter the shape of leaves which have to withstand extremes of temperature. She has fitted out a whole race of trees with needles instead of flattened leaves, because by exposing small and narrow surfaces the trees lose less from transpiration than is the case with wide plane surfaces. This is the great family of conifers, or cone-bearing trees, which may be found braving mountain storms and winters perilously near the Arctic Circle. They may also be seen toasting under the sun of Mediterranean summers—as may also some kinds of broad-leaved evergreen trees, such as the olive and different sorts of ilex or evergreen oaks.

The controlling influence in the lives of trees is always water supply. In the tropics, trees in river valleys and other well-watered lands grow to immense size. They have no resting season; new leaves constantly replacing those that fall with age. In the deserts, such trees as grow are of entirely different form. There we meet the cactus, with its fleshy limbs stored with water to maintain life in the tree; and the aloe and the palm. These again, by the peculiar shapes and coverings of the leaves, are able to subsist in very dry situations.

Nowadays, tree planting—or *afforestation*, to give it its full name—is not practised as much as it should be in this country, and what planting there is, is done for divers objects, the provision of landmarks not being one of them. Primarily, afforestation is carried on to provide timber, and for this purpose quick-growing trees such as larch and certain kinds of spruce and fir are most used. The oak and the beech are not now planted in sufficient numbers to maintain the supply of home-grown timber. But a very important aspect of afforestation strangely links two opposite

conditions. We plant trees to dry marshy ground, and we plant trees to bring rain to dry localities. In other words, afforestation and water supply may be very closely connected. We may find a condition of water shortage in areas that have lost their trees, and we may find also the very opposite—a water-logged condition in land from which the trees have been cleared. The fact is that trees act on the soil and on the atmosphere at one and the same time. Their roots spread out far into the surrounding soil and draw up immense quantities of water, which is converted by the tree into its own substances. Then, by the process of transpiration, the leaves give off warmed gases and water vapour, which appreciably warm the upper air. This in turn affects the condensation of the lower clouds, bringing rain. You are not to suppose that the felling or planting of a woodland here and there is likely to have any measurable effect of this kind. It must necessarily be on a large scale; but there are many regions in Europe where the destruction of great forests has brought disastrous results.

A different kind of danger has to be faced when large areas of trees are felled in hilly districts. This lies in possible damage to the soil. In all woodlands of deciduous trees the topsoil becomes very rich in leaf mould. But when the trees are felled, the rain beats on to the surface of the ground instead of falling gently down a staircase of leaves and branches, and the result of this, where the ground slopes sharply, is that the fertile part of the soil is carried away by the falling water. This has often been the case when hillsides have been cleared of their trees.

There is another way in which trees guard the fertility of the districts wherein they stand, keeping them pleasant and prosperous. In some parts they are of great value in preventing the encroachment of sand. This has been proved

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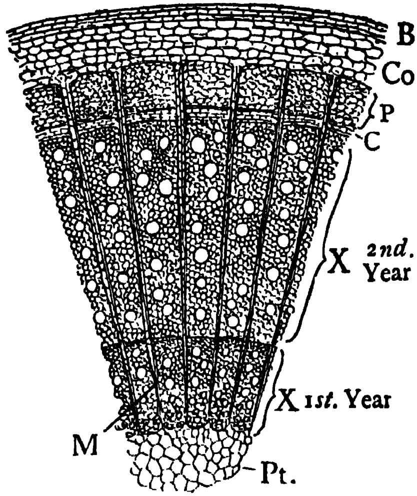
Drawing off the Latex from Rubber Trees

Leaves and Flowers of Rubber Tree (*Hevea Braziliensis*)

over and over again in Africa, where the felling of the forests has been followed by the rapid formation of sandy, sterile desert, blotting out the life of the community which throve there but a few years before. In the southern districts of the Sahara, this encroachment of the desert on agricultural lands in North Nigeria, French Niger and French Sudan has been very noticeable. Around the cultivated areas are tracts of bush or scrub where the nomadic tribes live and graze their herds. The cattle eat the young trees, and their owners cut down the tops from larger trees. This has the double effect of weakening the trees and diminishing the rainfall, and ultimately the trees die. Then, with nothing to hinder it, the sand blows in. In this way the Sahara is said to be advancing at the rate of a kilometre a year.

Although the timber of different trees varies immensely in appearance and quality, the botanical structure of trees is fundamentally the same. We all know what the cross-section of a tree trunk looks like—for who has not at some time found a stump recently sawn through by the woodman, and counted the rings to find out the age of the fallen tree? First comes the dark ring of the outer bark, then the paler ring of the inner skin, and finally the yellowish-white centre of the trunk. Of course, there are very scientific names for these parts of the tree. The outermost ring of dead, hardened cells is the bark; just beneath it is a slightly softer ring called the *cortex*. Next comes a layer of *bast*, or *phloem*, and then a narrow line called *cambium*. Next we find the annual rings, or *xylem*, one layer for each season of growth—that is, usually, for each year; and finally, in the centre of the tree, the *pith*. It is the narrow line of cambium which shows us most clearly the process of growth in a tree. The cambium cells divide and form new cells between groups of



Cross section of a two-year-old maple

B, Bark. Co, Cortex. P, Phloem. C, Cambium. X, Xylem of two years Pt, Pith. M, Medullary ray.

old ones. Thus the cambium is constantly being squeezed in opposite directions. The cells on its outer side change into bast, and those on the inner side change into xylem or wood. This is called sap-wood, and through it the sap passes upwards from the roots. It is the band of new wood cells which makes the permanent rings we can see in the stump. The bast is the means of carrying down the stem the nourishment which the leaves have absorbed from the air and sunlight and have " digested " ready for use by the plant—the products of the starch factory we glanced at in Chapter VI. The bark, or cork, is waterproof and cannot absorb any nutriment, therefore it dies, and as the tree grows it cannot expand, but cracks into the grooves and furrows which we generally associate with bark. The beech tree has a smooth bark. It is composed of an elastic substance and stretches as the tree grows. The pith is a

storehouse of starch and other food substances while the tree is young. As the tree grows older, and the cells harden or " lignify ", the pith is crushed and compacted so that it can no longer communicate with the bast, and having lost their function the pith cells dry and become filled with air.

Certain trees are covered with bark having very valuable qualities. Cinnamon, used by the cook and the druggist, is the bark of trees belonging to the genus Cinnamonum. The finest variety is that grown in Ceylon, whence seedlings were transported to the West Indies in the latter part of the eighteenth century. The fragrant bark is best when obtained from branches of not more than five years' growth. The outermost skin is scraped off, and the underlying skin carefully loosened and removed and spread out to dry. In the course of drying it curls, which accounts for the shape of cinnamon sticks. The sticks are all carefully graded according to the quality of the flavour, and this can only be proved by actual tasting. A slight flavour of cinnamon can be very pleasant—or so some people think—but biting and critically savouring newly-dried bark results in very painful blistering of the tongue and lips. Besides the essential oil [1] cinnamon yields another oil, very fragrant, which amongst native races is made into candles for the use of the great ones of the tribe.

Of universal importance is the bark of the cinchona tree, which yields quinine. Cinchona is found in Central and South America. The use of this bark as a remedy for tropical fevers was probably learnt by the first Spanish settlers. It was introduced into Europe by the wife of a viceroy of Peru, the Countess of Chinchon, in 1639. The countess

[1] Essential oils are secreted in minute glands in flowers and other parts of plants, and give characteristic scents and flavours, as oil of cloves, lavender, violets, &c.

had been cured of a serious fever by the use of the bark, and the tree was subsequently named after her, but in those days the remedy was called " Countess's Bark " or " Countess's Powder ". After this, the Jesuit missionaries in Peru made great use of the bark, and carried it to Rome, even then a malarial city, where it was dispensed free to all who needed it, under the name of " Jesuit's Bark ". On account of this name, the Protestant countries refused to have anything to do with the new drug, and the medical profession also opposed it with the greatest bitterness. But towards the close of the seventeenth century an English apothecary named Robert Talbot, or Talbor, was appointed physician to Charles II and he boldly dosed his monarch with quinine when he lay sick of a fever, with excellent results. The next year he cured the Dauphin and other members of the French Court by the same means, and the efficacy of quinine was thus proved and at last accepted by doctors both at home and abroad. There is still plenty of need for quinine in spite of the wonderful conquest of the malarial mosquito in many parts of the tropics. There is one point, however, which I want you particularly to notice. *Quinine is the only vegetable drug which cures disease.* There are plenty of vegetable extracts which bring relief, freedom from pain, and induce sleep, but there is not one other which actually fights the disease germ. Perhaps we should except the bark of the tulip tree (*Liriodendron*) which contains a substance called *liriodendrin*, similar in its constituents to quinine and capable of being used as its substitute.

Of the trees which are common in Britain most are grown for timber—apart from shelter and ornament, or else for the sake of their fruit. We have no need to attract rainfall, and we have no large areas of marsh to drain, nor shifting sands to contend with. In warmer countries, however,

there are many trees which are grown for the sake of the juices they secrete. The most important nowadays is the rubber tree. There are many tropical trees which exude a milky juice known as *latex*, which can be hardened to make rubber, but the most important is the variety *Hevea Braziliensis*. The process of making what we now call rubber was known centuries ago to the natives of South and Central America. The latex is carried in a series of tubes in the cortex of rubber-producing trees. When a slit is made in the cortex the latex trickles out and is caught in bowls. The primitive way of hardening it is either by the infusion of certain leaves which cause coagulation in exactly the same way as rennet causes coagulation of milk, or by slow drying in wood smoke. These methods produced the purest rubber, but are too slow for modern needs. During the first half of the nineteenth century interest in rubber was gradually awakening and, since the South American product was very costly, experiments were made with trees growing in the British Empire—in Africa and India, for instance. But the rubber thus obtained was of poor quality. At last some Brazilian seed was smuggled out of the country and brought to Kew Gardens, where a number of young trees were raised. These ultimately found homes in the Malay Peninsula and other eastern countries, and in Ceylon, and since that time innumerable plantations have been brought into bearing.

Another commercially important tree juice is turpentine. This may be obtained from several kinds of pine tree, those most used for the purpose being the swamp pine of America, and the *Pinus maritima* of France. The bark is cut and a little channel prepared through which the turpentine runs into vessels placed to catch it. The cuts have to be made higher each year, and the turpentine collected during the

first year is the best, because it has a shorter journey down the outside of the tree. As the channels grow longer, some of the turpentine hardens before it reaches the collecting point, and is then called frankincense.

Oddly enough, the turpentine of commerce, the sort of which I have been speaking, and which we have all used at one time or another, does not come from the true turpentine tree. This tree is the Pistachia, and it yields a resinous juice called chian turpentine, which is used for flavouring. It also gives us Pistachio nuts. Another tree of the same genus provides the resin called mastic, which is used as a chewing gum in Eastern Europe. But if we started talking about the different kinds of trees of which the bark yields resins, gums and latex of one sort or another, this chapter would never be done.

CHAPTER X

The Soil

If you were going to lay out a garden, or plant an orchard, you would need to be very much concerned about two things: the one, the aspect of the ground, and the other the character of the soil. The aspect is simply the direction in which the ground looks; whether it is sunny or shady, well protected or exposed to cold or drying winds. Of course, we cannot alter the position of our ground, but we may be able to do something either by wise planting of trees or by clearing away trees, to give protection or to let in sunshine. If the plot is shaded by somebody else's large trees or by buildings we cannot do much in the way of improving the sunshine, but we can improve the soil so that the plants lack nothing of what can be supplied for their nourishment. Even though we cannot change the aspect, when we have improved the soil, we shall be able to find plants to make good use of it.

To anyone interested in growing plants, the soil is an extremely important thing, needing very careful study, and calling for an immense amount of hard work to keep it in condition—" in good heart " as we say. Soils vary enormously in kind and quality, even over quite small areas. There are very few things I cannot grow in my own garden because I am fortunate in possessing several quite distinct types of soil. In the highest part of the garden there is a

fine black soil of sandy peat. This gradually gives place to a rich deep loam which has resulted from the cultivation of the ground through hundreds of years, probably; and on the other side of this good " garden soil " there are clay and gravel. Whatever my plants want in the way of soil, I can give it to them. There are also a stream and a swamp and a pond, so I consider myself very fortunate indeed. Yet I am always at work to improve my soil. If there is such a thing as a soil so good that it cannot be bettered, I have yet to hear of it.

Whatever the nature of the soil, it is always a mixture of ground-up rocks. All the soil in the world has resulted from the gradual wearing-down and breaking-up of the rocks of the earth's crust, through millions and millions of years. Sometimes it has been ground by the action of glaciers and rivers, sometimes by volcanic action, but mostly it has been the work of rain, frost, sun and wind, aided by those very primitive plants, the lichens, which I spoke about in Chapter IV. The rocks gradually decay—even the hardest of them; we say that they " weather ", and there is literal truth in the term, for the weather is the most powerful force in their destruction. Wherever they are exposed to air, the rocks slowly crumble away to form soil. Sometimes the particles are coarse and sharp, and we then call them " sand "; if they are very fine they make silts and muds of one kind or another, while if they are reduced to the very smallest size they become, in time, compacted into the stiff and sticky substance called clay.

Most rocks are inorganic, which means that they are purely mineral in origin; they are made of quartz, felspar, iron, phosphorus, magnesium, sulphur and other such things as make up the earth's crust. But there is another very important class of rocks—the limestones—which,

though they are compounds of the metal calcium, which is certainly inorganic, are sometimes spoken of as organic rocks. Coal is an organic rock, because it is made up of vegetable remains. Lime is an organic rock because it is largely made up of animal remains. Lime was secreted by humble forms of marine animals in the seas of past ages, and the limestone rocks are composed, for the most part, of vast accumulations of the tiny shells and skeletons of these creatures. Lime is a very important ingredient of fertile soils. Indeed, only a very small proportion of flowering plants can thrive in a soil which does not contain some form of calcium.

Another thing required to make good soil is the presence of organic matter, that is, it must contain the decayed or decaying products of animals and plants. It is for this reason that river mud makes, in time, a very fertile soil, because, as the river wore down the rocks and washed down the resulting sand it also carried with it uprooted plants, branches of trees and vegetable matter of all kinds. This vegetable matter gradually rotted away and its remains became buried in the mud, putting into it what is called "humus". Eventually the river receded, or changed its course, and left behind it layers of rich soil, called alluvial mud. Such soil makes some of the most fertile valleys all over the world, for rivers are impatient things and most of them now follow courses entirely different from those of their early days.

But the bulk of our soil has been made by the process of denudation—the slow, steady wearing down of the rocks by changes of temperature and the action of water and carbonic acid gas. Rocks are split by frost and particles are worn away by wind or rain, and if this happens in a dry area the result will be sterile sand. But let this sand be

blown into a crevice together with vegetable refuse and "weathered" there by rain and dew, and the vegetable matter will rot down, giving off carbonic and nitric acids, and in time to come the crevice will be filled with a pocket of good soil. The acids work in two ways. They are valuable to plant life, and they also dissolve the rocks themselves. Volcanic rocks, such as granite and basalt, are the most intractable, or hard to deal with, but lava—by itself quite infertile—eventually becomes broken up into a particularly rich soil.

For making a good garden soil we need four chief ingredients: clay, sand, lime and humus. Each by itself would be useless. Clay is cold, wet and heavy; sand is dry and "hungry"; chalk or lime is cold and pale in colour—an important point—and wanting in essential plant foods, and humus is not a soil in itself, but merely a part of the soil. The name clay is loosely applied to any earths which remain sticky after becoming wet. They have the quality of retaining moisture to a great degree, in such a manner that their particles all adhere in a plastic mass—which is why plates, jugs and basins are made of clay. Clay is impervious to water, and therefore clay soils are often water-logged. The sand—large, sharp particles which retain little or no water and would be too hot and dry for cultivation by themselves, corrects the heaviness of the clay when the two earths are well worked together. But a mere mixture of clay and sand would lack organic qualities. These come from the humus, which helps to retain moisture and heat and, by its decomposition, provides the nitrogen required by plants.

When we have our four chief constituents well mixed, we shall have a soil of which the particles are free and separate, allowing for plenty of ventilation and for free

percolation of water. Each particle is able to surround itself with a film of moisture. In this way air, moisture and the gases generated beneath the surface are able to circulate freely through the soil, and are available for the roothairs to absorb.

Plants, however, need something besides the air and water which the well-balanced soil aims at providing. They want food, and that comes from the chemicals bound up in the soil particles, ready to be unbound and set free by water and the gases in the soil. Therefore the cultivator wants to know what chemical substances the rocks composing his soil are made of. Broadly speaking, he knows that they are mainly made of compounds of alumina, felspar, calcium, iron, sulphuric acid, phosphoric acid, nitric acid, and potash. Some rocks have more of one thing and less of another, and to obtain a good soil, we must see that the chemicals are in the right proportions and that no essential plant nutrient is wanting. Sand or clay in undue proportions makes a very troublesome soil to deal with. Sands are poor in food-material and often quite infertile. It is true that you can grow bulbs—hyacinths, narcissi and snowdrops—in moist sand, for the bulbs contain in themselves the necessary stores of food; bulbs, corms, and tubers being, in fact, plants with self-contained larders. Clay goes to the other extreme. It is usually very rich in the things plants need, but they are so securely locked up that the roots cannot get at them, even if they are able to make headway into the dense sticky mass.

The soils which have resulted from limestone rocks are usually very fertile. Lime, in itself, is not a plant "food", but it brings about chemical changes in the soil which enable plants to make better use of the other food materials. We say that it "sweetens" the soil, by neutralizing excess acids

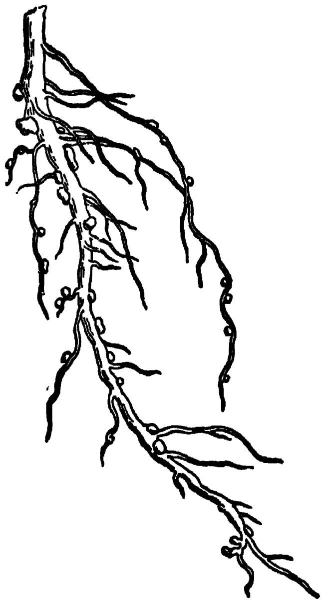
—for the production of acids, of several kinds, is a first step to the unlocking of the chemicals in the soil. The presence of lime therefore is necessary to prevent the soil becoming sour, especially if it contains much organic matter. Farmers and gardeners regularly spread lime on the land, but they have to be careful not to overdo it, for fear lest the crops should suffer from a form of iron starvation or " anæmia ". This is a condition in plants called *chlorosis*, which, by making it impossible for the leaves to manufacture enough chlorophyll, gives to them a whitish or dirty yellow look, instead of the rich green they ought to be.

I have mentioned that chalky soils are often unsatisfactory, even when they possess the right " texture ", neither too open nor too close. Sometimes this is due to a lack of lime—which seems very odd, for chalk is a very pure form of lime. The explanation lies in the fact that lime is soluble, and that the lime originally contained in the chalk has been dissolved out of it by the rains of ages.

The kind of soil which the gardener most covets—the richest soil of all—is that which contains a great deal of vegetable mould. This is the humus, which provides the organic material. The decomposition of the organic matter releases nitrogen—the most important plant food—the bread and butter of the vegetable community. The chief part of the process of decomposition, the business of breaking up the complicated cell materials of dead animals and plants, and resolving them into simpler substances which can be used again for building up new cells, is carried out by bacteria. As we learnt in an earlier chapter the bacteria represent the lowest of the five main divisions of the vegetable kingdom. They are unicellular plants, this is to say, each bacterium is composed of only one type of cell. They

are not merely the chief agents of decomposition, for of the many kinds of bacteria which live in the soil some kinds are essential to the growth of the higher plants by bringing the nitrogen (ammonia) into such a condition that the roots can absorb it. These bacteria are such tiny plants that it is hard to realize that they are so completely necessary to the life of the garden, field and forest. They are so small that a cubic centimetre of fertile soil may contain as many as 15,000,000 individuals. They are not all good bacteria, though, and so add to the difficulties of the husbandman.

Because it is the foodstuff most in demand by plants, and the one most quickly lost to the soil, farmers and gardeners are generally worried how to provide for their land supplies of manures containing sufficient nitrogen. All organic matter is largely stored-up nitrogen, so any animal or vegetable substance will be useful as manure. The green leafy parts of plants ought always to go back to the soil to give up their nitrogen again. Leaf mould and peat are useful in the same way, and so, of course, are all kinds of animal manure, though in varying degree. Hoof-parings from the shoeing-smith, bones and blood from the butcher, shoddy from the cloth manufacturer, waste from the wool merchant —all these, and indeed anything else that comes from plants and animals, have more or less nitrogen to give. But, because there is not nearly enough of such organic manure to go round, cultivated plants are never far removed from the threat of nitrogen starvation, and we have had to call in the help of chemists to find us more nitrogen. Sometimes the chemists obtain it from the supplies in the air. But most of it comes from the gas-works, where it is recovered from the fossil plants of coal, in the form of sulphate of ammonia. This is a very rich fertilizer, but it burns the



Root of a leguminous plant showing tubercles

leaves of plants and destroys the roots unless it is applied to the land in very small doses.

I have just said that some of the nitrogen used for feeding crops comes from the atmosphere, which, as you know, is mostly composed of this element. It seems odd, perhaps, that plants which are able to absorb carbon from the carbon dioxide in the atmosphere should not be able to get their supplies of nitrogen from the same plentiful source. However, there is one class of flowering plants which has discovered how to use the atmospheric nitrogen. These plants belong to the Natural Order Leguminosæ, which includes the pea and bean families. If you dig up a growing pea or bean plant, or a related plant such as broom or gorse, you will find on the roots little hard lumps or *tubercles*. These are nitrogen stores which certain bacteria living within the tubercles have helped the plant to manufacture from the free nitrogen in the air. These leguminous plants, when dug or ploughed into the soil, supply useful nitrogenous manure.

We may think of the nitrifying bacteria as " slaves " working to maintain the more highly organized members of the plant community. They are not the only vegetable " slaves ", however, for some sort of fungi perform a similar function. I have told you elsewhere that the fungi never

contain chlorophyll, and on that account they can only exist in the presence of decaying organic matter. Now, there are some soils so rich in organic matter—the humus deposits, like peat and leaf-mould, which are the accumulation of the autumn leaves of ages—that most plants find it difficult to grow in them. These humic soils are so acid that the nitrifying bacteria cannot live in them, and consequently the higher plants are also unable to thrive. In cultivated land, it is easy enough to neutralize the acidity by adding lime. And even on land untouched by man, as on heaths and in forests, Nature has found a way by which the flowering plants can get at the potential stores of nitrogen. On the roots of beech and birch trees, and on heaths and such-like plants which grow on peaty soils, there are to be found root-like threads. These are not roots, though to all intents and purposes they fulfil the functions of roots. They are filaments of a fungus called *mycorrhiza*. They act like real root hairs, attacking the humus and transferring nitrogen to the plant.

Apart from nitrogen, the most important chemicals taken from the soil are compounds of the elements sodium, phosphorus, potassium, magnesia, iron and sulphur. These and other elements needed for making plant tissues are absorbed by the roots. All except potash and phosphorus are wanted in such small quantities that there is no need to worry about providing them—there is enough and to spare in the soil. To ensure the big yields of produce expected from cultivated plants it is necessary to add to the soil regular supplies of potash and phosphoric acid. Wood ash is an excellent source of potash, and for this reason all woody garden rubbish, cabbage stalks, hedge trimmings and the like, ought to be burnt. The bonfire ashes must be stored in a dry place until the time comes to put them on

the soil for the benefit of *growing* crops. Sulphate of potash and a substance called kainit are both important potassium fertilizers. To supply their land with the necessary phosphates cultivators either use superphosphate of lime, which is manufactured from rock deposits found in Africa and America, or basic slag, a by-product obtained from the smelting of certain iron ores which are rich in phosphorus.

If you want to know something about the productive quality of any particular patch of soil, have a look at the weeds that are growing upon it. On sandy soil you will find lesser bindweed, musk mallow, speedwell, hawkweed, chamomile, shepherd's purse, poppy and bracken; on damp marshy ground, cuckoo flower, horsetail, comfrey, forget-me-not, marsh marigold, sundew; on chalk or limestone soils, penny cress, cheddar pink, hawksbeard, chicory, fumitory and bladder campion; on clay soil, dock, coltsfoot, sow thistle, rest harrow; on good, well-mixed soil, thistles, groundsel, goosefoot, dandelion, chickweed. On good soil also hedges and trees grow larger, leafier and more luxuriant.

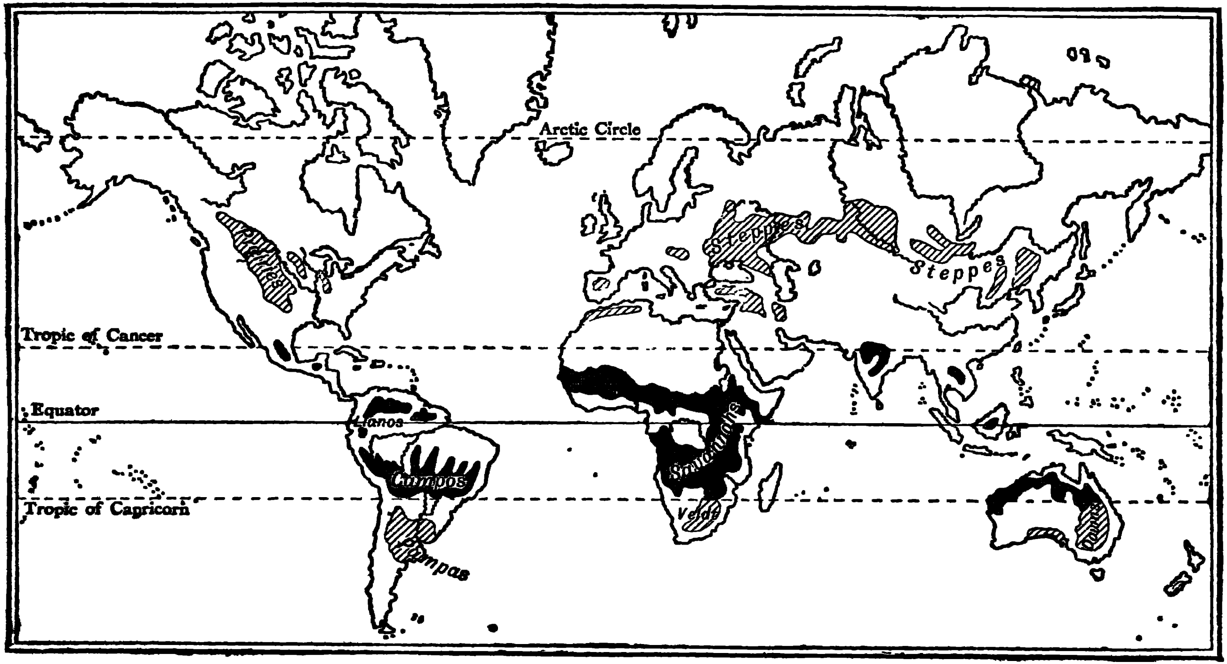
I have left to the last the most important thing about the soil. When all is said and done, fertility is mainly a matter of spade and plough. Dig, dig deeply—and then dig again. *By the sweat of thy brow shalt thou eat bread.* When you are tired of digging, get the hoe; and when you are tired of hoeing—dig.

CHAPTER XI

Blades of Grass

It is now the turn of the monocotyledons. We have stumbled over the word several times already, and it is time we took a closer view of the division of the angiosperms with *one* seed leaf instead of two. We couldn't get along without the monocotyledons, for they provide us with the bulk of our food. One reason for this is that the seeds of most monocotyledonous plants contain very large stores of nourishment; not, primarily, for us, but for the use of the young plant when the embryo begins to grow.

There are other conspicuous differences which help us easily to distinguish between the plants with one cotyledon and those with two. It is difficult to examine the dry seeds without a microscope, but a newly-germinated seed shows you, at a glance, which division it belongs to. In any case, the structure of monocotyledons differs so completely from that of dicotyledons that it is easy—except in a few cases—to distinguish them. Look at the leaves first. If the veins are parallel, or nearly parallel, you are fairly safe in assuming that the plant you are examining belongs to the division monocotyledons, for the dicotyledons always have net-veined leaves. Further, the stems of monocotyledons have no central column of pith, and no bark which can be pulled away. Examination under the microscope reveals great differences in the structure of the stem. The fibro-vascular



MAP OF THE GRASSLANDS OF THE WORLD

Tropical grasslands in heavy shading. Grasslands of temperate regions in lighter shading

bundles are seen to be scattered about in the stem, instead of being arranged in regular rings.

Another odd thing about the stems of monocotyledons is that they hardly ever branch. Here are some familiar examples: grasses, lilies (to which great Natural Order belong those admirable plants the onion and the leek), irises, or " flags ", palms of different kinds. They all have long, narrow, sword-shaped leaves and the plants do not branch.

In this country the only palms we see are dull, dingy things in pots; but in the warmer parts of the world where their homes are, the palms are fine trees, with great columnar trunks. With hardly any exceptions, they have no branches. There is a tall stem bearing at its summit a crown of leaves. As the trunk grows upwards the lower leaves fall off, and if you can imagine a dandelion growing so that it was always getting taller, and always keeping its tuft of leaves at the top of the stem, you will have a good idea of how a palm tree grows. The flowers of monocotyledons generally differ greatly in type from those of dicotyledonous plants, but where petals and sepals are found they occur in threes, instead of in fours or fives. I have already mentioned the most important members of the division, but you will easily be able to think of varieties, for they include all the plants we generally refer to as " bulbs ". The arum is another example we all know, as represented by the " lords and ladies " of the hedges, and this genus is interesting as being an exception to the parallel-veined rule. The most important members of the division, however, are in a class by themselves. They are called collectively—*grasses.*

Roughly speaking, about a third of the world is covered by grasses of one sort or another. There are the vast prairies of North America and the rolling plains of South America;

BRITISH GRASSES AND SEDGES

1, Vernal grass. 2, Timothy or cat's-tail grass. 3, Fox-tail grass. 4, Bent grass. 5, Tufted hair-grass. 6, Wild oat. 7, Couch-grass. 8, Perennial rye-grass. 9, Rough stalked meadow grass.

BRITISH GRASSES AND SEDGES

1, Sheep's fescue. 2, Cock's-foot grass. 3, Dog's-tail grass. 4, Quaking grass. 5, Annual meadow-grass. 6, Reed. 7, Bulrush. 8, True sedge. 9, Cotton grass.

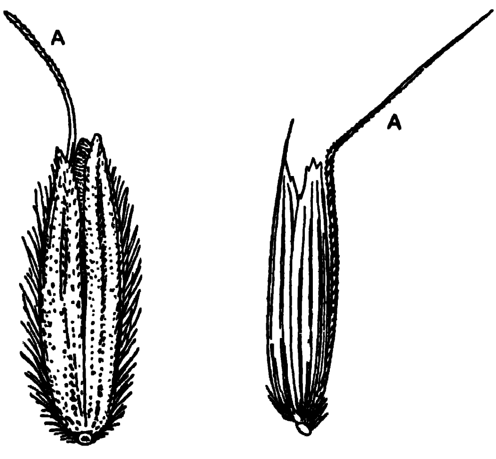
the steppes of Russia; the rice-fields of India; the veldt of South Africa; meadows and pastures and cornlands in every continent. Even the short summer within the Arctic circle produces its hay crop. As food plants, the grasses have no equal. Meadow grasses feed cattle, cereals of many kinds feed man, and his domestic animals and birds. Another very important article of food is obtained from the gigantic grass called sugar-cane. Bamboos, which are of great economic value, are grasses, as are also all sedges, reeds and rushes; some of which are useful for basket-making, paper-making, thatching, &c.

In our lawns and meadows we have plenty of specimens of the plants generally indicated by the name "grass", and a short examination will show us several different varieties. The gardener usually likes to make his lawns of moorland turf, because the grass which grows in exposed situations is short and fine. Such grasses are fescue, agrostis, crested dogtail and poa. If he cannot obtain moorland turf, the gardener has to be content with meadow turf, which contains coarser grasses, such as rye grass, as well as troublesome weeds like buttercups and daisies, yarrow and plantains. The good gardener always makes his lawns by sowing grass seed, because he can get rid of weeds and their seeds in the ground before he sows the grass, and he carefully selects the kind of grasses to suit the soil and locality. Lawns are very easily spoilt by the introduction of bad grasses. One of these is the broad-leaved kind called "Yorkshire Fog", which makes nasty yellow patches when it is mown. But of all the undesirable grasses which trespass in gardens the worst is twitch or couch grass. This pest belongs to the same family as wheat, but, although it has some value as hay, if cut early enough, and is sometimes grown to bind loose sand, it has none of the good qualities of its relation.

Twitch is greatly disliked by the gardener because of its creeping stem, which grows underground very rapidly, sending up coarse green shoots at intervals. Every little bit of stem left in the ground will grow, and as it is very brittle, it is a tedious matter to pick up every piece.

Another grass which soon becomes a troublesome weed is that called Darnel. It much resembles rye in appearance, and is hard to distinguish from rye grass. But the darnel is believed to be poisonous both to man and cattle. The wild oat is a much more attractive grass, having its flowers hanging from long stalklets instead of close against the stem as in darnel and rye grass. These flowers are furnished with long "awns" which help with the scattering of the seed. Whenever you come upon one of the awn-bearing grasses you should look at it very carefully, for it is a most interesting instance of the specialization I have spoken about elsewhere.

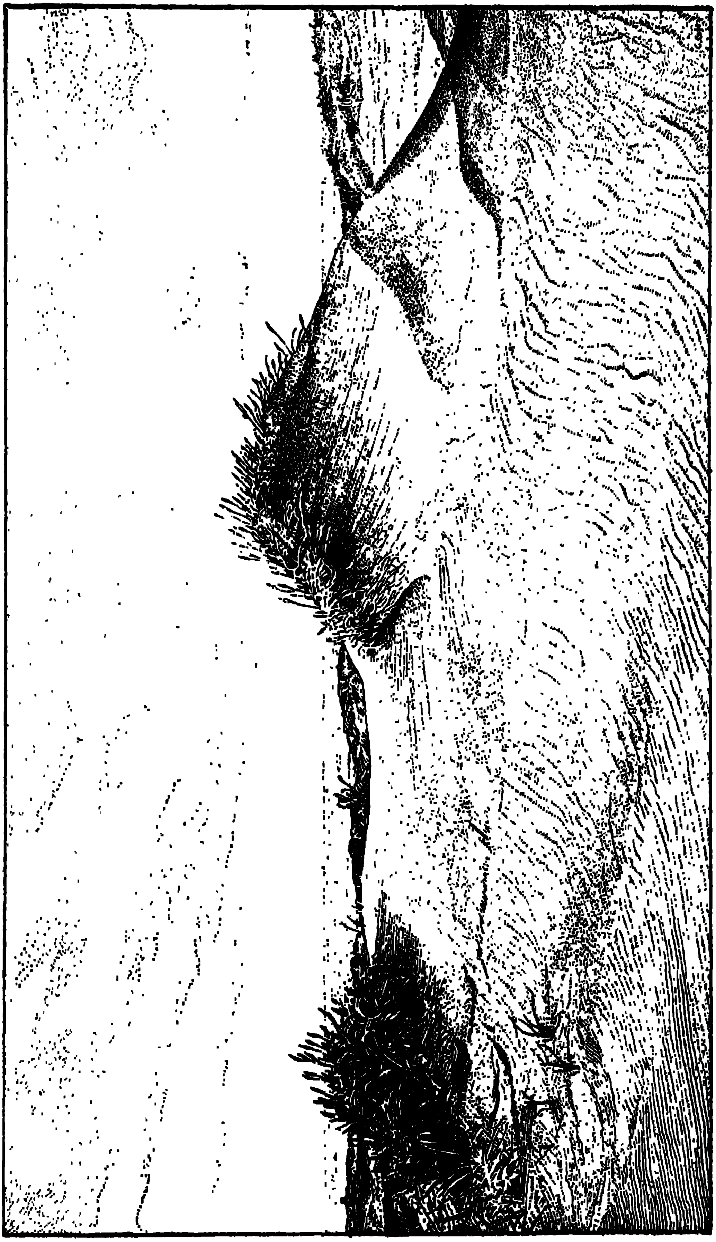
The awn is a vegetable-gimlet. If we examine a wild oat we shall notice that the *bract*, or covering of the seed, terminates in a very long spine which is bent abruptly at an angle, and has also a slight corkscrew twist. This is the awn. The other end of the seed-covering is provided with a hard and extremely sharp tip, while farther back there



Magnified seeds of meadow foxtail (left) and tall oat
A, A, Awns

are stiff, bristle-like hairs pointing upwards. The awn is extremely sensitive to moisture. When the air is very damp, the awn absorbs moisture and straightens out; you can easily see for yourself what happens by wetting an awn and then drying it by the heat of a fire. As it becomes dry it bends over and takes on a twist, and the twist is conveyed to the seed. In short, the seed has a power of movement imparted to it by the moisture-affected awn. As the air becomes dryer or damper, so the awn twists and untwists, and the sharp-pointed seed is screwed into the ground, the stiff, upward-pointing hairs preventing it from being drawn out again. In some countries sheep are killed by the awned grass seeds driving irresistibly through their skins, under the influence of changes of atmospheric humidity. The awns are so sensitive that country people once used to mount a wild oat to serve as a "poor man's weather-glass". The awn is not really prophetic, of course; it merely indicates whether the air is damp or dry. If it is damp, the awn stands erect; if dry, it droops and twists.

The grasses which grow near water frequently show very strong tall forms, and then we call them reeds or rushes. Most people are familiar with the reed-mace which grows in or around ponds throughout the temperate zone. This is a tall plant with leaves an inch wide, bearing a velvety dark-brown cylinder of female flowers, surmounted by a tuft of yellow male flowers. The bur-reed has narrow leaves, and the stem divides at the top to carry rosettes of flowers, dark-brown male flowers above and golden female flowers below. The bulrush has a cyme of brownish flowerets, resembling wheat in shape. The common reed grows in masses beside ponds and rivers. It is very tall and has a silky plume of greyish purple flowers. It is one of the most valuable plants for thatching and mat-making.



MAR] GRASS ON THE ND-SWEPT SAND-DUNES

There are many grasses which grow on or near the sea-shore, and are never really happy without salt in their food. These grasses are of great value in binding the loose sand which lies above high-water mark. Marram grass is one of the commonest of such grasses and is sown on the coast wherever it is desired to strengthen the sand dunes and prevent erosion by the sea. It makes a tall plant, often as much as four feet high, the leaves rough and bluish green, the flowers being long green spikes with yellow anthers. Its roots (more properly they should be called underground stems) are creeping and very tough and strong. They may run along for a distance of thirty feet, and can be used as binding material, especially in thatching.

Marram is probably the coarsest grass grown in Britain, but in southern Europe and northern Africa the growing and marketing of a large grass called Esparto is a flourishing industry. This obliging grass will grow wild on the poorest soil and can survive long periods of drought. Where conditions are more favourable it can be harvested twice in a year. Its uses are innumerable. It can be made into carpets, sandals, ropes, baskets and nets, sacks and bags of all descriptions, but its most important place in commerce is as material for paper-making. Many hundreds of thousands of tons are exported annually from both shores of the western Mediterranean.

In the countries of its origin the bamboo fulfils a number of uses. This form of grass grows freely throughout southern Asia and the north of South America. Some tropical bamboos grow at a terrific rate and reach an immense height, some species growing as much as a hundred feet. The wood is light and very strong, and suitable for every sort of building; and also for water-pipes, masts, rails and fences, fishing-rods, tools of many kinds and

BAMBOO

household utensils. A coarse matting can be made from split canes, which can be applied to the making of furniture, sails for boats, &c. The canes can also be steeped and converted into paper. The leaves are used for thatching and mat-making—for hat-making too, while the young shoots are edible and can be served in a variety of ways, either fresh or pickled. Some species of bamboo exude a sugary substance which is sold under the name of Indian Honey; others produce a strange compound of silica and potash known as Tabasheer, which has the appearance of a quartz or fragile marble, sometimes semi-transparent, and sometimes opaque, of pale colours and beautifully veined. It is easily powdered and is regarded by the Hindus as a powerful tonic. In South America there are two kinds of bamboo which secrete delicious water in the stem spaces between the nodes. When I add that some kinds of bamboo bear seeds which can be used as rice and for making beer, you will realize that they can supply every necessity of man. And as I have already mentioned, the bamboo grows with the utmost rapidity, as much as three feet in a day being the rate of some tropical species.

Economically more important than any other kind of grass we must rank wheat. True, its uses seem pitifully narrow when compared with those of the bamboo, for it will only make bread and straw, but in making bread it makes the food of civilization. Wheat is grown throughout the temperate zone; but "The Granary of the British Empire" is Canada. The Prairie Provinces of Canada, Manitoba, Saskatchewan, and Alberta once formed the bed of a sea, and the resulting soil is deep, black and fertile. But it is not only the suitability of the soil which has led to the development of Canada as one of the world's chief granaries; the reason is to be found in a combination of

soil and *climate*. The splendid Canadian summer provides sixteen or seventeen hours of hot sunshine a day to ripen the grain. Wheat must have sunshine, which is the chief reason why wheat-growing must always be a somewhat hazardous business in our own uncertain climate. It is, indeed, a very high tribute to the skill of the English farmer

Maize

On the left can be seen ears with mature fruit and some not quite ripe with the styles still showing. On the right is a male flower head.

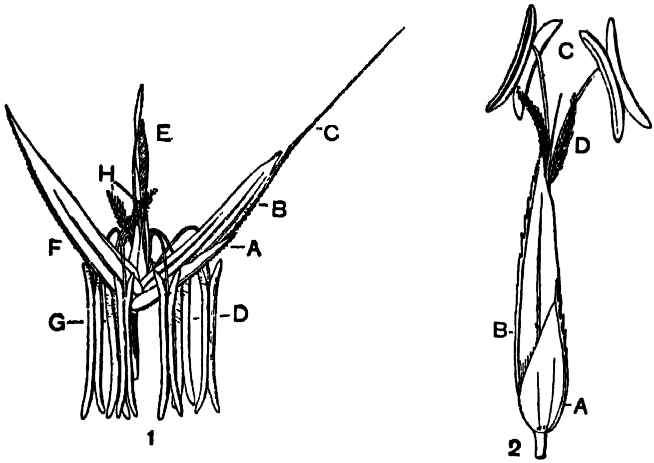
that, in spite of natural disadvantages, he succeeds in getting a much higher yield of wheat from every acre he sows than is obtained in any other country in the world. The Canadian wheat harvest is reckoned in millions of tons. We import most of our wheat from Canada; the United States sending us the next largest amount, then Russia and the Argentine.

Russia is a land of vast plains of rich soil. Nearly a fifth of the world's total wheat supply is grown in Russia, the

amount produced there being more than twice the output of Canada. The climate—and consequently the produce—of Russia varies from the Arctic to the sub-tropical, so we need not be surprised to learn that its southern provinces grow maize and sugar. Maize is an extremely interesting grass and a very important article of commerce. I strongly advise you to grow a few seeds of maize in your own garden, for the plant is a very beautiful one and the young unripe corn-cobs, known as "green corn" or "sugar corn", are delicious boiled and served with butter. Although maize does not ripen in this country it is growing in popularity, both as a "vegetable" and as fodder for cattle.

If you want to grow maize you must get the right variety. It takes a much longer growing period than most grasses take to ripen their seed, but some sorts are quicker than others. It is no use sowing the maize grains out of the chicken corn. Get a gardener to give you a few seeds, or buy a small packet of the sort called "Early Sunrise" or "Early Sugar Corn". Look at them before you sow them. They are quite unlike any other grass seeds you have ever seen—hay seed or wheat, barley, rice, oats or millet. For one thing they are curiously flattened at the sides, because when they were in the fruit or "cob" they were squeezed up against each other very tightly. As with all the monocotyledons, the seed contains a tiny embryo, with thread-like radicle and plumule; most of the seed is occupied by the endosperm,[1] which is stored-up starch. The seeds can either be sown singly in small pots, indoors in a warm room in April, and transplanted into well-dug soil in the latter half of May, or you can sow them in the garden about the middle of May. They must have a sunny position and plenty of water.

[1] See diagram on page 52.



Flowering spikelets of: 1, Tall oat, and 2, sweet vernal grass

In the tall oat. A, Lower glume. B, Lower part of male flower. C, Its awn. D, Its three stamens. E, Its upper pale. F, Upper glume. G, Three stamens of perfect flower. H, Two feathery stigmas of perfect flower.

In the sweet vernal grass. A, Small lower glume. B, Large upper glume. C, Two stamens. D, Two brush stigmas.

Now, as I have told you elsewhere, the grasses have not troubled to make themselves attractive to insects. They have no brightly-coloured flowers, no nectar (except in a very few cases), no sweet scent. Insects occasionally visit them, but these flowers can get on perfectly well without them. For fertilization they depend on the wind. The male flowers produce enormous quantities of pollen, the grains being very small and smooth, and the stigmas are so arranged that this dust-like pollen can easily reach them. In the maize flower the stigmas are drawn out to an immense length so as to make sure of catching the wind-borne pollen. When the maize comes to flower, the young cob is seen to be closely wrapped in a sheath of leaves, from which presently emerge strange silken threads. As they grow the threads hang down like beautiful tresses, each being from twelve to twenty inches long. Each thread is a stigma,

Head of sugar-cane plant

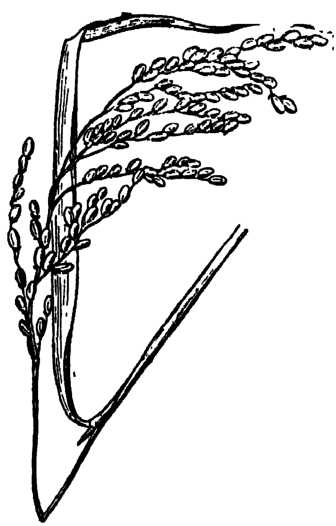
a, Single flower. *b*, Part of a bunch of flowers

leading directly from the embryo in the seed-to-be. The male flower is borne at the top of the stem, and is an ornamental sort of tassel producing masses of light, dry, loosely attached pollen.

The sugar-cane has been in cultivation for many thousands of years, as it was certainly known in India before the Christian era, and was in common use in the East when Alexander the Great imported it into Asia Minor. In the

seventeenth century the Dutch took it to Brazil and the West Indies. The juice from which sugar is made is secreted in the stem, which grows to a height of twelve to fourteen feet with a tuft of silky flowers, very much resembling the flower of ordinary grass, at the top. In cultivation the flowers do not form seed, but the plant is propagated from "eyes" on the stems. The roots also throw up fresh shoots for many years in succession.

Rice is a grass which provides the staple food of nearly one-third of the peoples of the world. It is indigenous in the East, and another quite different species is indigenous in North America. It needs to be planted in very wet ground, often artificially flooded for the purpose, and trodden by bullocks into a squelchy mass. The rice-fields are flooded twice more during the season of growth, and the ground must be kept free of weeds, even though the labourers sink to the knees in the wet ground. Rice was introduced into America from the East in the latter half of the seventeenth



Panicle of rice

century and Carolina rice is considered the best for all purposes.

There are many different varieties of all the grasses producing cereals. Plant breeders have given farmers kinds of wheat, barley, oats and other grains, specially suited to particular soils and climates, and to meet the special requirements of consumers. The maltster, for instance, wants quite a different sort of barley from the sort needed for feeding pigs or poultry. But of all the cereals, rice can show the greatest number of varieties. No fewer than fourteen hundred different kinds of rice are on view in the Calcutta Museum. As might be expected, seeing that it is the staple food of many hundreds of different tribes, occupying half a continent in the eastern hemisphere and a large part of the western hemisphere, rice is not always called rice. In fact, it has over a thousand different names.

CHAPTER XII

Vegetable Oils and their Uses

It is customary to speak of the present time as the Age of Machinery. It would be just as correct to speak of it as the Age of Oil, since oil is essential to the running of any form of machinery. The yearly consumption of oil is truly enormous. Most of the oil used for commercial machinery is mineral oil, but there is another kind of machinery—living animal machinery—which requires a different kind of oil. All the moving parts of an animal need constant oiling, and the animal also needs fat to keep itself warm. For these purposes it uses animal fat and vegetable oil.

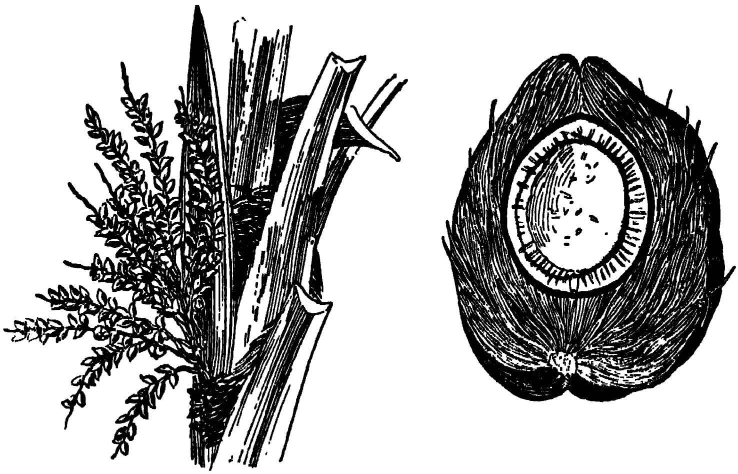
Some creatures, as you know, are carnivorous and obtain their oil from animal fat. Others are herbivorous and all their oil comes from nuts and seeds. Man generally takes some of both, but he is making bigger and bigger demands upon the vegetable kingdom for his supplies of oil. Birds and cattle are given hemp seed and rape to provide them with oil. " Oil-cake ", which the farmer offers his stock in winter-time, is made from the residue of oily seeds, such as cotton, linseed, hemp and rape, after a certain amount of the oil has been extracted. The meal made from the crushed seeds is formed into cakes and partially cooked. They keep for a long time and furnish a very useful food for cows to turn into milk. Linseed is the seed of the flax plant, and linseed oil is principally used for mixing with paint and varnishes.

The meal formerly had great repute amongst nurses for poultices, which are now regarded as an old-fashioned remedy for diseases of the chest. Flax, of course, is grown primarily for the sake of the stem fibres which are spun to make linen thread. When the crop is harvested the seeds are removed from the stalks by a process called rippling. This is performed by a tool known as the rippling comb, which has iron teeth eighteen inches long. The rippler takes up each bundle of flax in turn and draws first one-half of it and then the other through the teeth of the rippling comb, when the seeds fall into a receptacle placed to receive them. Flax grows in most parts of the world, and another equally well-distributed plant which is useful both for seed and fibre is hemp. This grows throughout the temperate zone, and can also be cultivated in the tropics and in northern Russia. Oil of hempseed has a nasty smell, but can be used for burning in lamps if nothing else is obtainable; it can also be made up into paints, varnishes and soft soap.

Rape is a member of the cabbage family, and is a close relation of the turnip. It loves a rich soil, and is largely grown in the Fen district, and also in the south of England on the chalk lands. The plant is useful to the farmer in a variety of ways, for it can be planted and grown to a certain height and then ploughed into the land that raised it to act as a green manure. Or sheep can be turned into a field of rape, which may be tall enough to hide them completely, and left to eat their way through, though it is a rich diet and can easily cause disease. Where the crop is grown for seed the dried haulm still provides a good cattle food or may be spread on the ground as manure. The cake made from the crushed seeds is not as nourishing as linseed cake, but the oil is valuable for machinery and for burning in lamps. Colza oil is very similar to rape oil.

In all sub-tropical climates the olive has been the chief source of vegetable oil for countless centuries. The tree lives to a very great age, many specimens still in existence being over a thousand years old. As its usual home is in dry, warm climates, the leaves are leathery to reduce transpiration. It is a fidgetty plant as regards soil and aspect, and refuses to grow in certain districts which might be thought favourable. It has been transplanted to the New World quite successfully, and is extensively grown in California, Florida, Mexico and Chile. The best oil is made from olives grown in Tuscany. The olive chiefly grown in Spain is of a different variety and produces an oil which only Spaniards seem to like. Several varieties of olive are grown in South Africa, but only on account of the wood, which is so tough and hard as to be called iron wood. All olive wood is hard and takes a high polish. The oil is not expressed from the stone but from the fleshy part of the fruit. The first oil extracted is the best and is called " virgin oil ". The pulp is then mixed with water and pressed again, when a second-grade oil is obtained. A third pressing gives oil only suitable for soap-making and other commercial purposes. In the countries of the Mediterranean olive oil takes the place of butter and cream, since in those regions milk is scarce owing to the poverty of the pasture. The olive, in fact, constitutes a very valuable industry, since the oil is so much used in the country of its origin, and is in such great demand for export.

The coco-nut has long been well known in this country as a source of food and drink for the inhabitants of the country in which it grows. The coco-nut palm (*Cocos nucifera*) is a handsome tree reaching a height of ninety feet, with a great fan of leaves springing from the top. Amongst the leaves, close to the trunk, the flowers hang in



Coco-nut. On the left is shown the inflorescence and on the right the nut in its fibrous husk.

spathes, male and female flowers being borne on the same spadix. The tree begins to fruit when it is seven years old, and continues bearing for seventy years or more, at a rate of anything up to two hundred nuts a year. The hard outer covering being removed from a ripe fruit, the kernel is exposed. This is the coco-nut we see in the shops or on rows of little sticks at fairs. The covering of the kernel itself is very hard, as most of us know. The three little marks, or eyes, at the base of the nut, which we pierce when we want to draw off the " milk " have given rise to the name of " coco " nut, *cocos* being a Spanish word meaning mask or bugbear. These three little marks can easily be imagined to form a grotesque face. The milk is a particularly useful fluid, food and drink combined, and is very refreshing when the nut is green and freshly picked. The solid white meat is very rich in oil—in fact, the oil content is seventy per cent of the whole.

This oil, when expressed from the nut, is one of the most

valuable of tropical commodities. Originally it was used in a liquid state as lamp oil and for cooking, or in a solid state for making candles and ointments. But since the introduction of margarine the demand for coconut oil has increased a thousandfold. It is pure and wholesome, and can be deprived of its distinctive flavour when worked up with other ingredients.

The coconut palm grows freely in all tropical regions, and is always the first tree to appear on the new islands of the Pacific—volcanic islets or coral atolls—as soon as enough sand has banked upon them to give roothold. The reason for this is that the woody outer husk of the nut acts as a little boat which transports the kernel in safety from the parent tree—growing where the coconut palm most loves to grow, near to the sea—to a new home on a sandy beach.

Another constituent of margarine is furnished by the ground nut or monkey nut (*Arachis hypogæa*), a botanical curiosity as well as a source of wholesome food. This little plant flowers and fruits in the ordinary way, but as the

Ground nut or monkey-nut plant

pods swell the stalks droop and force the pods underground, where they ripen. The plant requires a hot climate, being a native of Africa, from which it was transplanted to the southern United States, probably at the same time as a cargo of slaves. It is grown with some success in the south of Europe. When roasted, the nuts have a pleasant sweet taste something like almonds. Some people don't trouble to roast their monkey nuts—they like them raw. I always wish they would eat the shells too. The oil expressed from the nut is nearly equal to olive oil in flavour and does not readily become rancid.

The Soya Bean (*Soja hispida*) is a plant which grows in Eastern Asia, and produces an oil which is a staple article of food for the natives of those countries. The oil is increasingly imported into this country as a substitute for olive oil, as it is cheap and palatable. In 1934, for the first time in the history of horticulture, a crop of soya was raised successfully in England. Many attempts had been made previously both here and in Germany, but never on so large a scale nor with very encouraging results. You will not readily guess the reason which led to the experiments being made at Boreham in Essex, where this rich harvest has been obtained. The soya bean has recently become a valuable crop in the United States. Mr. J. L. North, late curator of the Royal Botanic Gardens at Regent's Park, has persevered in the raising of seed suitable for sowing in England, and he it was who provided the seed for the twenty-acre plot at Boreham. This land is part of a large estate owned by Mr. Henry Ford, the American manufacturer of motor-cars, and the oil from the beans is to be used in his English factory at Dagenham.

Man's necessity has often induced him to overcome natural obstacles. It was said that soya beans could not

Branch of walnut showing male flowers (*a*) and female flowers (*b*). Enlarged views of the male and female flowers are shown at top and bottom. At the right is a section of a walnut.

ripen in England, that the summer was too short and not hot enough, that the frosts of late spring and early autumn would ruin the crop. Undoubtedly, the summer of 1934 was unusually fine and favourable, but the weather was only partly responsible for the result. More credit is due to the patient labours of the men who, over a long period of years, tested and discarded and tested again different types of seeds to find those most suitable for English conditions. Soya bean is another of the plants which can be ploughed in as green manure, on account of its high nitrogen content. The soya, too, is remarkable among plants be-

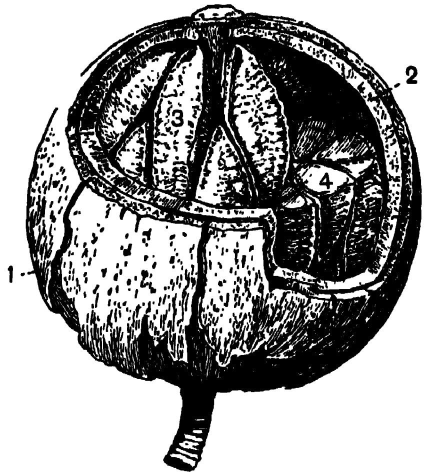
cause it contains the substance casein, which is a valuable part of our diet generally obtained only from animal sources.

Apart from these oil-bearing nuts, we have many trees which give edible nuts. Hazels are a common feature of the English hedgerow, while their more refined cousin the filbert is cultivated in orchards. In spring we search the copses eagerly for the tiny tuft of crimson blossom, the female flower of the hazel, which is so much harder to find than the long conspicuous catkins of the male flower. Hazel nuts yield a quantity of oil when pressed, called commercially nut-oil. This is used by painters for mixing with their colours on account of its quick-drying properties.

The walnut is one of the handsomest of trees of the temperate zone. It grows to a large size, and its foliage, like large heavy ash leaves tinged with copper and bronze, contrasts strikingly with that of the oak, elm, or beech. Like the hazel, the walnut is a source of nut-oil. It is interesting to note that the name walnut is derived from the German *wallnuss*, foreign nut, and the Welsh name for the tree signifies French nut. The date of its introduction into these islands is uncertain, but as it was known to the Romans it may well have been one of the many kinds of fruit brought in by them.

Another nut which ripens in England is the Spanish chestnut. Although its real home is in the warm countries of the Mediterranean, this beautiful tree has become acclimatized to more northerly conditions and the English fruit, though small, is sweet and appetizing. In Italy, the chestnut is a valuable food of the poorer classes. Its Latin name, Castanea, is derived from the town of Castanum, in Thessaly. The nuts can be eaten roasted or boiled, or can be ground to make bread. They contain fifteen per cent of sugar, and are nourishing and delicious.

Brazil nuts are great favourites, and generally appear at Christmas time. Most of us have made a Brazil nut candle by cutting a section of the nut and sticking it upright in a slice of apple. When a lighted match is held to the piece of nut it will catch fire and burn with a clear flame. Brazil nuts yield nearly sixty per cent of oil, and on this account are a valuable food. The oil can be used for burning. The tree which bears these nuts (*Bertholletia excelsa*) is a native of Brazil. It is a magnificent tree, often reaching a height of 120 feet. The nuts are contained in a large and very heavy pericarp in which they are tightly packed in four divisions containing eight seeds each. It may well be imagined that when the fruit is ready to fall it is not wise to stroll about beneath a *Bertholletia excelsa*, as one of these hard and heavy seed vessels falling from a height of a hundred feet or so would make a considerable dent wherever it fell.



Pericarp of *Bertholletia excelsa* cut open to show the brazil nuts. 1, Husk. 2, Hard wood pod. 3, The nuts all fitting into each other's rough triangular facets. 4, Nuts cut across.

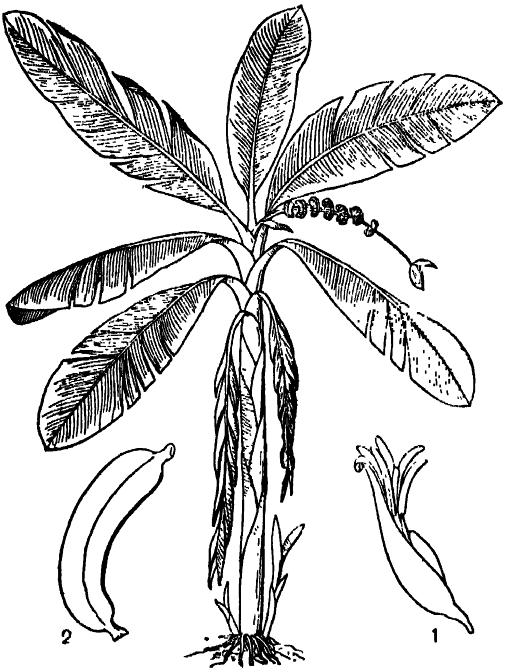
There are other strange nut trees in the Brazilian forests, one of them (*Lacythis ollaria*), being known as the monkey-pot tree. The seed vessel of this tree resembles an iron pot thoughtfully provided with a lid and is actually used for cooking purposes by the natives.

CHAPTER XIII

Under the Bark

We have seen how the vegetable world can supply us with food, drink, medicine, clothing, building and roofing materials, and how, by the aid of modern science, its products can be made to satisfy all our wants. There is one vegetable product, however, which we have not yet considered, although its use was discovered in the very early days of mankind. This product is fibre. The stalks of certain plants will split up into strong fibres capable of being twisted or woven. Flax and hemp are the most common of such plants, but it is probable that our very early forefathers used many others which served their purposes well enough even though they would be useless for commerce nowadays. You will have read something about flax and hemp in the last chapter, for the seeds of both give up a useful oil under pressure. Hemp is a tall plant, and the long stalks must be soaked in water for a considerable time before the fibres can be freed from the soft tissue. Then they are dried and spun into thread, the threads being twisted to form twine of the required thickness.

Hemp is grown in the temperate zone, in most European countries, though not very largely in Britain. In the United States the state of Kentucky grows the most. It needs a very rich soil so that the plants may grow rapidly while young, thus making long fibres. The seed must be sown



Manilla hemp plant

1, Flowers. 2, Fruit.

thickly if a fine fibre is required, and thinly for a coarse one. The stalks are pulled up by hand. The younger they are pulled, the finer are the fibres, but if seed is wanted as well, the male plants must be left until the flowers have scattered their pollen, and the female plants must stay in the ground until they have ripened their seeds, by which time the fibres are very coarse.

Jute is made from the fibres of a species of lime tree cultivated in India—and as a matter of fact our own lime tree provides fibres which can be made into cord and paper. The jute plant proper is *Corchorus capsularis*, and is grown chiefly in Bengal. Its fibres are strong and coarse and rather

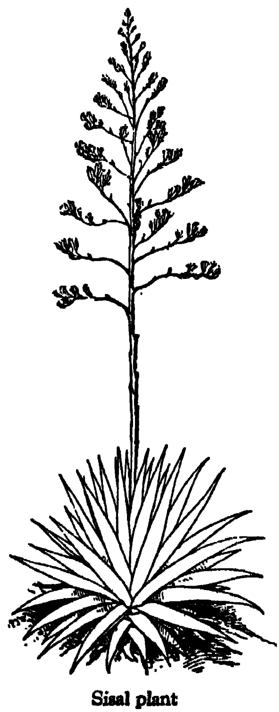
woody by nature, but by careful treatment they can be softened sufficiently for making into carpets, where their silky surface is very effective. Jute carpet, however, is not very durable. The manufacture of jute occupies a great deal of the trade of Dundee, whence brightly-dyed prayer-mats for Moslems are annually exported in large quantities. But more jute is woven into backings for carpets than into carpets themselves, and it also makes ropes, sacking and mail-bags, tarpaulin, &c. It is sometimes used to adulterate silk and flax, but being much less durable than either of these and quickly affected by damp, the materials in which it has a share soon show signs of deterioration.

The cultivation of flax must be a very old form of husbandry. Evidence of the plant is found amongst the remains of the Stone Age in Italy, and in the Swiss lake-dwellings, while another proof of its antiquity is the fact that the word " lint " occurs in all the languages of Europe with but slight modifications. Antiquaries regard this as showing that lint or flax was a commodity used by the handful of people from which all the European races are descended. The cloths used to wrap the mummies of ancient Egypt were always of linen, and drawings of the plant appear on the walls of tombs. In bygone days the area under flax in Britain must have been very great, but it is no longer grown here, and even in Ireland, which used to grow large quantities, the culture has dwindled sadly. We find it cheaper, presumably, to import our flax and linen goods from one of the great flax-growing countries, for example, Russia, the countries of Central Europe, or certain of the United States.

The stalks of flax are pulled up by the roots by hand, and are then sorted out into uniform lengths. After the seeds have been removed, the stalks must be " retted ", or steeped, to separate the fibres. " Dew-retting " produces

the silkiest fibres, by which process the stalks are spread out in rows on the grass and are left there to weather for a long time. " Water-retting " is the quicker and more general method. The bundles of stalks are weighted with stones and kept beneath the water of a shallow pool for ten days or a fortnight, until fermentation has reached a certain point. This occasions a most unpleasant smell, which is, in fact, so bad that special legislation had to be introduced at one time to prevent people from turning the water out of their retting pools into any stream. As this water is a valuable manure, it is better in every way to turn it out on to the land.

You have probably seen in gardens a plant with broad fleshy leaves tapering to acute points, and adorned with little spikes on the edges, a grey-green plant edged with white, the leaves shooting up and outwards from the root. This is an agave; and if you take hold of the acute point at the tip (when the owner is not looking) and give it a sharp pull, it will break off, bringing with it a strong fibre from the whole length of the leaf, providing you with an excellent needle and cotton. The agave, which is doubtless being grown in the fond belief that it is an " ornamental " plant, will never be quite the same again.


Sisal plant

Nearly all the agaves are fibre-giving plants, but one in particular, *Agave sisalana*, is the origin of a

very important fibre called sisal. In Mexico and Central America, where this species of agave grows, sisal is the staple cordage, but it is also exported to Europe and the United States. Its especial use is for ships' cables, as it is very little affected by salt water. *Agave americana* and *Agave mexicana* are other agaves whose fibres are of great commercial value, being woven into matting and cloth as well as used for twines and ropes.

There are certain trees which are less valuable for their timber than their pith. One of these is the sago palm. This useful tree propagates itself by side shoots from the root and also by seed, so having once made a plantation of sago palms all you have to do is to watch them grow, and keep the ground clear of weeds. At about fifteen years of age the tree may profitably be cut down and will be found to contain in its stem about six hundred pounds of edible pith, a spongy substance which only needs drying and grinding to be used as food. The home of the sago palm is New Guinea, Java, Sumatra, Celebes, Borneo, Malacca and Siam, and the pith is used by the natives of these countries as a staple article of food, either cooked as a porridge or baked in thin cakes. Its use in Europe is well known—too well known, some of us think—as sago pudding, but it is also used to feed stock and to adulterate cocoa. I may mention here, perhaps, that that even less palatable compound called tapioca pudding is not made from any relation of the sago. Tapioca is made from the root of the Manioc, the same plant which supplies the cassava of the West Indies. But when the grocer sells you Pearl Tapioca, he is selling you neither sago nor manioc, but common potato!

One of the most important developments of commerce in recent years has been in the production of cellulose. This substance is secreted by plant cells to make the cell

walls, and therefore enters into the construction of every part of the plant. Science has shown how the cellulose may be recovered from the plant which has made it, and it can be converted into an astonishing number of different substances. Dextrine and glucose are among the first of the derivatives; such diverse things as gun-cotton, silk stockings and varnish can all be made from it.

The idea of making silk from wood is not new, because many years ago men who had studied the silk-worm came to the conclusion that a silk thread was really nothing but a thread of gum squeezed through a small hole. Wood was known to contain gum—what more likely than that wood could be made to give up its gum, which might then be drawn into threads? The story of the invention of the machines which finally achieved this result does not belong here; suffice it to say that to make "viscose" a tree is reduced to small chips, boiled, beaten to a sheet, broken up into crumbs, dissolved into a thick, sticky semi-fluid which is finally forced through nozzles having infinitely fine holes. The minute beads of gum adhere together and the fine jets issuing from the spray harden into continuous threads which are twisted together to make a thread strong enough to be handled. The finished product has a brilliant lustre, and we may say that it is the coming of cheap cellulose which gives the life of to-day such a highly polished surface. Fabrics for dress and furnishings, paints and varnishes for motor-cars and finger-nails, all owe their gloss to cellulose; while the highly-glazed appearance of chocolate boxes, cakes and novels is due to a neat and hygienic wrapper of cellophane. Everything shines, and yet things cost no more than they used to. All these wonders are ours because the living protoplasm in vegetable cells is always at work secreting the material for building cell walls.

CHAPTER XIV

Plant Protection

Though plants provide food either directly or indirectly for the whole animal kingdom, they do so unwillingly, and the various ways in which they try to protect themselves are of great interest. We have already seen with what care the holly grows prickly leaves on the lower branches that are in reach of grazing animals, while higher on the tree the leaves become much more simple and have but one remaining point on the end. It is remarkable that holly responds in exactly the same way to shears, and if a holly tree or hedge is clipped, however high it grows the leaves will be as prickly at the top as they are at the base.

But the holly is only one of many prickly or thorny plants. The hawthorn has not prickly leaves but is provided with true thorns, that is, modified branches that have become pointed as a protection to the plant. The rest-harrow is also provided with thorns, but it is peculiar in that these thorns only occur when the plant is growing on poor soil. The honey-locust grows small thickets of thorns out of its trunk, thereby successfully discouraging any attempts at tree climbing, and some of the scrubby acacias present to the desert world little beyond a tangle of thorns and spines.

It is not, however, only shrubs and bushes that have developed this protective armour, for many herbs have done the same. Perhaps the best known of these is the

thistle. The succulent stem and leaves are covered with singularly unpleasant prickles that protect the plant successfully from all but the hardest-mouthed animals, such as the donkey and the goat which, by their evident enjoyment of their mouthful of thistle show how necessary is this protection if the plant is to survive. It is noticeable that in a temperate clime, plants protected by spines have a taste that is peculiarly attractive to the grazing animals.

Spines and thorns are not used only for protective purposes. Many are used for climbing. The hooked spine of the rose and bramble are provided for this reason. If a bramble has been cut near the root it is much easier to pull it out of a tangle of growth from the top than from the bottom. The reason is not difficult to discover. If we look at the thorns on the stems we shall see that they are all hook-shaped, and if the bramble is growing through thick vegetation these catch the branches and twigs and prevent the long growths of the bramble from being blown down or torn away. Some of the climbing palms and rattans retain their hold over the plants up which they wish to climb in a somewhat similar manner.

An opuntia or prickly pear

But to return to the subject of plant protection: spines and prickles are perhaps the most obvious way of warding off the attacks of marauding animals. But those we have glanced at so far are weak and inoffensive compared with the elaborate self-protection of the desert plants, the cactus and the euphorbia. These may be provided

with spikes up to a foot long, growing in profusion, arching and interarching and making any near approach to their fleshy green substance quite impossible. Some, such as the opuntias, grow small barbed spines that detach themselves easily from the plant. These enter the skin of the attacking animal, and though nothing is easier than to push them farther into the flesh, to draw them out is almost impossible.

The thorns and prickles so far discussed have not been poisonous. The barbed spines of the opuntias are very unpleasant and may set up inflammation, but they are not supplied with poison by the plant. There are, however, certain plants that form their defences of prickles, or hairs, that are actually poisoned. Commonest and best known of these plants is the nettle. The leaves and stalks of this unpleasant plant are covered with small hollow hairs. These hairs are very brittle, being made of a substance we may describe as a vegetable glass, and when touched they usually break and the sharp remaining point pierces the skin. Inside the hollow hair is a poisonous liquid, consisting of formic acid, which enters the puncture in the skin and causes the painful sensation so annoyingly familiar to most of us.

The British nettles are certainly disagreeable, but their sting is slight and unimportant compared with that of some of the larger foreign species. The great Scrubby Nettle of Northern India is a particularly offensive plant. It forms a shrub fifteen feet high, and has broad glossy leaves that have no appearance even of hairs. Sir Joseph Hooker in his *Himalayan Journals* says: "I gathered specimens without allowing any part to touch my skin; still, the scentless effluvium was so powerful that mucous matter poured from my eyes and nose all the rest of the afternoon in such abundance that I had to hold my head over a basin for an hour."

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QUEEN OF THE NIGHT

A beautiful cactus growing in South Africa. The blossoms, which are about 6 in. in diameter, open at sunset once every year, closing for ever as soon as the sun grows hot the following morning.

This nettle is obviously not a plant to be trifled with and Teschenault, a French botanist who got sadly stung by such a plant, gives a very alarming picture of the result. At first he could feel no more than a slight irritation but in an hour his whole hand felt as though it was being rubbed with a hot iron. The pain spread up the arm and then his jaw contracted, terrifying him with the thought of lock-jaw. Six or seven hours after being stung the pain began to abate, although it was well over a week before it finally left him.

In Timor, the sting of the Devil's Leaf may last for a year, and may even kill its victim, while in Australia a certain tree—*Laportica moroides*—has so powerful a sting that even horses are killed by touching its leaves. The poison ivy (*Rhus toxicodendron*) is a climbing plant that grows abundantly in certain districts of North America, and it has caused a great deal of annoyance and bother to explorers who have come across it unawares. There have been occasional cases of people growing it over their houses, for it has attractive leaves, and is similar to the Virginia Creeper, for which, indeed, it has been mistaken, and it has produced soreness of the eyes, nose and throat, while when touched it brings out a nasty rash. Masefield, in his book *Odtaa*, gives an extremely vivid account of the effect of inadvertently climbing a tree over which poison ivy happened to be growing. The face of the victim was so swollen that no trace of a feature remained.

An interesting form of protection is used by the dead-nettles and some of the campanulas. They have grown so as to resemble almost exactly the stinging nettle in appearance, and no doubt after being mistaken for the imitated plant they are left severely alone, though they are really quite harmless. Another very common form of plant pro-

tection is the secretion of juices having offensive smells or tastes. There are many bitter herbs and plants in the fields and hedges that are not eaten by cattle. The poisonous buttercup, however plentiful amongst the grass, is never eaten by grazing animals because it has a bitter, unpleasant taste. Similarly, the cowslip and the foxglove do not suffer when they grow in the fields. These plants are poisonous, and it is suggested that animals know instinctively which plants are poisonous and refrain from eating them. It is far more likely that the animals do not eat anything that tastes unpleasant. If they like the taste of a poisonous plant they are foolish enough to eat it and consequently die. Cattle are not infrequently killed by eating yew, particularly if it is growing in the hedges of a field of poor pastureage. When this happens it may be considered a general failure all round. The poison developed by the plant has been of no avail in protecting it from being eaten, and the foolish animal has been killed by its own carelessness and greed.

Possibly the most remarkable form of protection against grazing animals is that affected by the Sensitive Plant (*Mimosa pudica*) and the Telegraph Plant (*Desmodium gyrans*). The Sensitive Plant is well known in botanical gardens (it can indeed be grown by anyone who has a greenhouse, for its seeds germinate readily), and apart from its cotyledons even its tiniest leaves are sensitive. The leaflets as soon as they are touched fall together and the leaf stalk droops, and the whole leaf appears to have folded up. This is what happens when any animal tries to crop it, and the movement and general retreat of the plant frighten him, causing him to try for his meal on some neighbouring shrub or herb not given to this peculiar habit of shutting itself up.

Ordinary position Position when touched

Sensitive leaves of *Mimosa pudica*

The Telegraph Plant has leaves that jerk and move about both day and night, the motion being particularly noticeable in bright sunlight. It is thought that their constant motion prevents the leaves being eaten, the animals being frightened by the surprising and unexpected movement.

So far we have only looked at the plants that have discovered means to protect themselves against destruction by the larger animals. No mention has been made of the need for protection against insects. Enormous numbers of insects live on plants, eating their leaves, their flowers, their roots and their stems. Not only insects, but slugs and snails and aphides and mites, all attack and devour various parts of the plants. We shall see in Chapter XVI how in some cases the plants have turned the tables on these smaller

pests, but this retaliation is very unusual, and the plant world loses far more than it gains from its insect enemies.

As defence against insects, plants find acrid and poisonous saps even more useful than they do against the larger animals. Particularly so is the sticky, quick-drying latex that so many plants exude when they are crushed or broken. Dandelions and poppies are well-known plants that yield this milky fluid. Kerner in his *Flowers and their Unbidden Guests*, tells us of his observations on the latex from the lettuce. He noticed that the sharp hooked feet of various ants broke through the tender tissue of the lettuce leaves. Wherever there were punctures drops of white fluid appeared, and the ants' legs soon became sticky. They tried to wipe the fluid away, and in doing so still further scratched the leaf. Then they would try to escape by dropping from the leaf, and if they were not completely covered with the latex all was well. If, however, they had stayed too long the latex became spread over them, and in a few minutes hardened to a tough brown substance, and all their efforts to free themselves from it were in vain. Their movements became gradually fewer and weaker, until finally, they ceased altogether.

In warmer countries these latex-yielding plants become more numerous. In some cases the milk-like sap is a valuable food, and the cow trees of South America when tapped give out a sap that is said to be hardly distinguishable from ordinary cow's milk. In Ceylon there is a similar milk-yielding tree. Rubber, again, is a latex that is poured out from any wound in the trunk of the rubber tree with the object of preventing insects from boring into its trunk. The idea is self-protection—not the provision of rubber balls and boots. It is interesting to note that rubber trees that have been drained of all their latex soon become riddled

by boring insects, which a bird of the woodpecker tribe—again owing to the absence of sticky sap—is able to capture.

Tannin is an extremely bitter substance which many trees and plants prepare to prevent themselves being eaten. Resins and balsams serve the same purpose, for the stickiness of these secretions deters the small insect from deep penetration. The buds of horse-chestnuts and the balsam poplar are both coated with a sticky gum which preserves them from the attacks of most insects. Pines and other conifers prepare resin in great quantities, and this not only drives away most attacking animals and insects but also forms an adequate covering for wounds, protecting them both from damp and fungoid attacks. The teazel stops insects climbing up its stalks by uniting its opposite leaves where they join the stem and forming a little cup in which water can collect and so prevent the insect from climbing farther. Many plants cover their stalks with hairs that discourage the visits of insects; and some, such as the catchfly and London Pride, to ensure that they shall not be visited from the ground, make their hairs sticky, and they then act in the same way as fly-papers.

Perhaps the most remarkable form of protection is afforded by those plants which keep armies of ants ready to drive away any attacking animal or insect. Kerner mentions four composite plants—*Centaurea alpina*, *C. ruthenica*, *Juminea mollis* and *Serratula lycopifolia*—that attract ants to themselves for this purpose. The buds of these plants are particularly liked by certain kinds of large beetle. To prevent their being eaten, the plants secrete great quantities of a honey-like substance on the large outer scales of the bud. This honey attracts ants which jealously guard their new-found store of food, and should any beetle appear it is furiously attacked by the ants and is almost invariably

driven away. When the bud has developed sufficiently to be no longer acceptable to the beetle, the secretion of honey ceases, and the ants retire to any other part of the plant that is signalling its need of protection by the copious outpouring of honey. There are also various acacias that make provision for ants to police their leaves and branches. These acacias, like most of their order, have large hollow spines at the base of the leaves, and it is in these that the ants live. Honey is secreted on the stalks of the leaves, and the ants have everything they require close at hand. Should any grazing animal try to crop the leaves, it will immediately be attacked by the ants and driven away. The imbarba tree has a hollow pithy centre in which ants frequently make their nests. Trees which are inhabited by these ants are always in a healthy condition, while those without them are damaged by various insects.

The plant world has to be in a constant state of defence against attacks of one kind or another, and it is remarkable what endurance is necessary in the struggle for existence. The vitality of grass, for instance, is amazing. It sends up edible, and for the most part unarmed, shoots that almost immediately are bitten off! Yet in spite of that the plant continues to thrive and grow. Were it not for this exuberance the vegetable world would be doomed. Were all plants as tender as those rare and difficult favourites we coddle in our gardens, very soon the face of the earth would lose its greenness. And without vegetable life, animal life also would soon be doomed.

CHAPTER XV

Parasites and Epiphytes

In the vegetable kingdom, as in the animal kingdom, there are members of society who do no work themselves, but live on the production of others. They are called parasites. Some of them, not having any drudgery to do, turn their activities into other channels and produce the largest and most gorgeous flowers; others are lazy; they have tiny insignificant flowers but produce abundant seeds.

To a certain extent, all plants are parasitical, inasmuch as they are dependent on the remains of organic matter in the soil. Some plants—woodland flowers such as the violet, the bluebell, the celandine—thrive on leaf mould—that is, leaves only partially decayed; but they are living on the waste products of the trees above them and they are improving the soil by the further breaking down of the leaf mould, and assisting in the eventual conversion of the organic matter into more simple substances that can be utilized by the roots of the trees. They are dependent on the trees, but the help they receive is in no way harmful to the trees. They are simply utilizing the waste products.

Then there are those plants, such as the bird's-nest and coral-root orchids, that have entered into partnership with various fungi. The roots of these plants are covered with fungoid threads that convert the dead leaves into foods that the plant can assimilate with ease. Consequently it

An orchid as an epiphyte with aerial roots

need do but little work itself and therefore its leaves are few and pale and deficient in chlorophyll. But again such plants are not truly parasitical, for though they live on leaves they only live on dead organic matter, and they are of use in breaking up and decomposing the leaf mould.

There are also the plants that grow on trees—the epiphytes. Mosses and lichens are frequently seen growing on the shady parts of tree trunks. In thick damp woods they may grow in considerable profusion. They are living simply on

the surface of the bark, and obtain their nourishment and moisture from the air and from bits of decayed bark and leaves.

In the forks of trees odd bits of leaf and twigs will collect, whereon bird droppings may fall, and eventually enough soil may accumulate for a plant to grow. This plant may be almost anything—grass or a gooseberry—but often in Britain it is one of the polypody ferns. Abroad, in the dense tropical forests, epiphytes are far more common. Orchids and ferns grow in huge profusion on the branches of trees in the forests of Borneo and Brazil. Heat and moisture provide ideal conditions and the plants luxuriate and grow with a wanton splendour and speed that make the English woodland seem tame and uninteresting. The fight for air and sunshine is such that only at the very top can green-leaved plants hope to secure favourable conditions. In the dim regions below the leafy canopy only those plants whose habits enable them to exist with little or no chlorophyll can grow. It is at the top, in the light, that the others must find a place.

A place in the sun can be found in two ways; either by growing from the ground all that long distance to the tree top; or a plant may perch itself on the tops of those sturdier plants that have successfully managed the journey. This the epiphytes achieve. They fasten themselves to the branches at the tops of the trees and so secure the necessary light. There also the necessary food and moisture are to be obtained. The branches are covered with a thick layer of liverworts, mosses and creepers, and rapid growth leads to rapid decay. Consequently there is ample leaf mould for the epiphytes' nourishment. Moisture they usually obtain by hanging down long aerial roots which absorb water like a sponge. In addition to this the leaves are often succulent

and act as storage reservoirs, and enable the plant to bear up successfully should there be a season of drought.

Another group of epiphytes, the bromeliads, form cups in the centres of their rosettes of leaves, and in these cups rain water collects. They grow in forests where rain is frequent, and they have thus a constant supply of water kept ready at hand for their immediate needs. This water generally smells very badly, as it contains the bodies of dead insects and other decaying matter, and it is thought that the bromeliad gains additional nourishment in this manner, though no digestive fluid is excreted, as is generally the case with the true insectivorous plants, such as we shall look at in the next chapter. These epiphytes, though they use trees for their support, and take from them some of the light and air to obtain which they have grown so high, do not actually harm the trees by taking their nourishment. The harm done by the smallest ones, in particular the orchids, is practically nothing, and what little damage occurs is amply excused by the glory of their flowers.

But there are other epiphytes than the orchids, and these are not always so inoffensive. There is, for instance, the Brazilian balsam (*Clusia*). It has handsome pink and white flowers and large shining leaves. Its seeds, which are good to eat, get carried off by birds to the forks of trees and there germinate in leaf mould and guano. It sends long roots down to the ground, these roots first of all being soft and following the surface of the trunk carefully. When they have reached the ground they begin to harden, and before long they send out bands of hard flat root round the trunk that supports them. As the tree goes on growing, and trying to increase in girth, these rings strangle and choke it. The tree gradually becomes sickly and dies, by which time the Clusia has strengthened its roots sufficiently to bear the

Palm stem used as a support by the lattice-forming stems of one of the *Clusia*

whole plant. The Clusia thus not only manages to borrow the light and air of the tree on which it germinates, but in time, having destroyed its original host, it is able to occupy the space so painfully won in the first place by the tree.

The Clusia merely strangles the tree that supports it, and the harm that it does is similar to that done by ivy or honeysuckle or, more humbly, by the bindweed or small convolvulus. The true parasite takes its nourishment direct from the plant on which it feeds. It sinks sucker-like roots into the branches or roots of the plant and appropriates for itself the sap prepared by the host plant for its own use.

In England there are only a few true parasites. The best known of them is the mistletoe (*Viscum album*), and those who kiss beneath it at Christmas time do not always realize

the true nature of this curious plant. It is found growing on the branches of a number of trees, the poplar, the apple and the elm being the most favoured. The oak, which Druidical tradition suggests as the proper host plant, is, strangely enough, hardly ever found harbouring mistletoe, and ceremonies of the Druids must have been very rare if they only occurred when mistletoe could be cut from an oak.

The manner in which the mistletoe spreads its seeds is of interest. A bird eating the white berries may get one of the very sticky seeds stuck to its bill. If this happens it will probably wipe it off on a branch. Or if the bird should swallow the seed, the tough skin will prevent its being digested, and when it is excreted there is a further chance of the seed being stuck to a branch by the bird-lime. If the tree chosen is suitable, the seed will germinate, and soon the young plant will pierce through the outer layer of the bark into the wood, and then it will draw on the sap of the host plant for its own nourishment. It is not entirely parasitic, for its leaves are green and it is able to take carbon dioxide from the air, and to elaborate in its own leaves the crude sap it has stolen from its host.

In Chile there is a relation of the mistletoe called Toranthus that grows on various cacti. It has masses of blood-red flowers that are often mistaken for the flowers of the host plant, for this Toranthus has practically no green leaves, and has therefore to take from the cactus not only crude sap but also more complicated substances, such as sugar.

Several British plants are semi-parasitic, such as the eyebright, the lousewort, the cow-wheat, red rattle and toadflax. All these have green leaves and are therefore only partly parasitic. The eyebright grows on poor soil among short grass. It is a conspicuous little plant with very

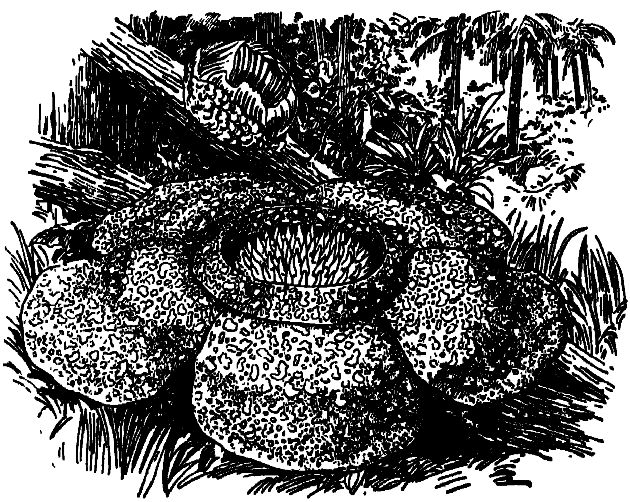
dark-green leaves and bright white flowers streaked with yellow. Above the ground there is no suggestion that it is anything out of the ordinary, but if we dig it up we shall find that it has short roots that are attached to the roots of various grasses, and it is from these grasses that it draws most of its nourishment.

The broomrape and toothwort are entirely parasitic. They have practically no chlorophyll, and are almost entirely dependent on the plants from which they take their nourishment. The broomrape is an unpleasant greenish-yellow plant that sends up spikes of flowers of a similar colour. It has numerous host plants, and the varieties are known by the name of the host, as yarrow broomrape, &c. The toothwort sends up clusters of unpleasant spikes of dirty white flowers that have an appearance of rows of teeth of doubtful cleanliness. More common than either of these is the dodder. Its pinkish stems of a thread-like fineness dangle over various plants, and it is only on close examination that we find that the threads are attached to the stems. Along the threads hang clusters of small pink flowers. The dodder has no leaves, for it does not work for its living, but it produces vast numbers of seeds and can in time become a great nuisance. There is one variety that grows on heather, another attacks the hop, another flax, and a fourth the clover. But it is not particular and will feed with equal freedom on a great number of different plants.

In tropical regions, parasites may produce flowers of enormous size. The largest known flower—that of Rafflesia Arnoldi—is fully a yard across. It is parasitical on the roots of various vines in the Malay States, and grows straight from the ground, having hardly even a stalk. The flowers are brick red spotted with yellow, and they have the smell of tainted beef. This smell, which is common to a number

of different plants (such as the Aristolochia) attracts various carrion-feeding flies, and fertilization is secured by their help.

By far the most common parasites are the fungi. Many of them grow on living plants and are very destructive and we shall read more about them in another chapter. Both epiphytes and parasites, as we have seen, show great ingenuity in their methods of stealing, and it is not surprising that as a class of plants their adaptability is also shown in other directions. Thus there is a species of Toranthus that produces a very sticky seed that on germinating throws out a root with a sticky disc on the end. If the seed falls on unsuitable ground the root bends over and the disc attaches itself. Then, straightening the stem, it tears itself away from the initial position. It can repeat this process and so move until it finds a position to suit it. Similarly the seeds of dodders produce long threads that wave about until they strike a suitable host.



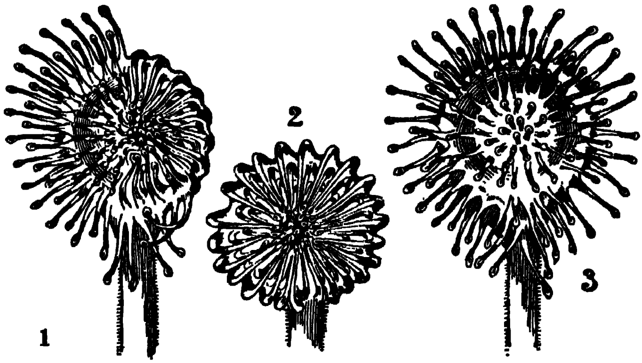
Flower and bud of *Rafflesia Arnoldi*

CHAPTER XVI

Insectivorous Plants

In the usual way, as we have seen, plants are dependent on the soil and the air for their nourishment. Those very lazy but marvellously adapted plants, the parasites and epiphytes, tap the roots or the stems of other plants to save themselves work, but even in these cases, their food is derived mainly from the ground. We are now going to glance at a comparatively rare class of plants, the members of which contrive to obtain additional nourishment by capturing insects and feeding on their bodies.

In boggy or peaty soils that are deficient in available nitrogen, insectivorous plants are particularly common. In such soils the conditions are unfavourable for the bacteria whose job it is to set free the nitrogen for the higher plants. In Britain, on heaths and moors, the sundew (*Drosera*) is quite frequent. It is easily recognized by its rosettes of red sticky-looking leaves. There are two common British species, *D. rotundifolia* and *D. intermedia*, one of which has round leaves and the other oblong. If we look at these plants carefully we shall see that each of their leaves is covered with long hairs at the ends of which there is what appears to be a drop of dew, but which is really a sticky fluid. Any passing fly or gnat stopping to investigate and settling on the leaf immediately becomes entangled in the gummy stuff. As soon as this happens the whole leaf be-



Tentacles on the leaf of a sundew (enlarged three times)

1, Leaf with half its tentacles over a captured insect. 2, Leaf with all its tentacles curved in. 3, Leaf with all its tentacles extended.

comes aware of the presence of the fly and the long hairs all bend down their drops of gum on to the unwary visitor. A digestive ferment is then exuded; those parts of the insect valuable for food are dissolved and absorbed by the plant. When this has been accomplished—which is in about two days—the tentacles uncurl and the leaf is ready for another meal. The sundews are well represented all over the world, and there is hardly a country where one or more species does not occur. The plants are all insectivorous and catch and consume their food in the same gluey manner.

Belonging to the same Natural Order (Droseraceæ), and even more remarkable, is the plant called Venus's fly-trap. It is a small plant with a rosette of leaves lying flat on the ground which grows in the United States, from Rhode Island to Florida. At the end of each leaf is a circular piece with extra strong parallel veins running from the midrib to the edge of the leaf, which is provided with strong teeth. In the middle of the circle six bristles stick up, thin and almost invisible. Should a fly alight on the leaf surface

THE LARGEST INFLORESCENCE IN THE WORLD

An Amorphophallus whose actual flowers, which are tiny, are collected round the base of the spadix inside the enveloping spathe

Venus's fly-trap

nothing will happen unless it touches one of the six bristles. The moment this occurs, however, the tooth-like leaf segments snap together with considerable force, and, the marginal teeth interlocking, the fly is captured inside the trap. A digestive fluid is excreted and the fly is absorbed.

It is remarkable that the six hairs in the middle of the leaf are the only sensitive part of the trap; the surface of the leaf can be scratched and irritated without causing the slightest contraction or movement, but the least touch given to one of the central hairs causes the leaf to close up. It takes from ten to twenty seconds to close the trap, but the digestion takes a long time. It may be two or three

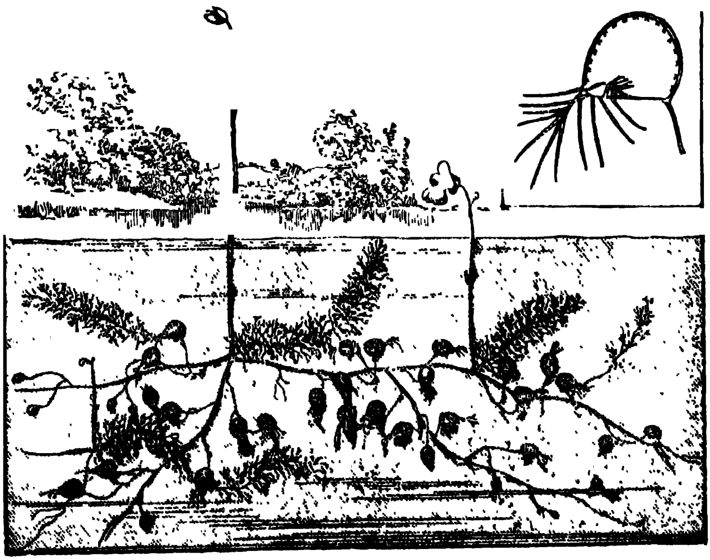
weeks before an insect is properly digested and the leaf ready for a further meal.

Another group of insectivorous plants is found in the butterworts. There are several British species, all of which are to be found on peat moors and bogs. The butterwort forms a rosette of pale green sticky leaves and it has attractive pinkish purple flowers. If an insect alights on a leaf it sticks to the surface. The leaf rolls up and excretes a digestive fluid and the fly is absorbed. The butterwort is an attractive plant and it is one of the best insectivorous plants for cultivation. The sundews and Venus's fly-trap, though interesting for experimental purposes, are disappointing because they both, but particularly Venus's fly-trap, succumb to over-feeding.

An interesting fact about these plants is that they seem to distinguish between foods and mere irritants. The hairs of the sundew will take no notice of a grain of sand or a drop of water falling on a leaf, but if they are offered a titbit such as a small piece of meat or a nice fly, they move immediately. And though Venus's fly-trap takes, as we have said, two or three weeks to open after catching a fly—if a grain of sand touches one of its sensitive hairs the leaf only remains shut for a short time. In like manner the butterwort leaf will only roll itself round something that it will be able to digest.

Related to the butterworts, and also insectivorous, are the bladderworts (*Utricularia*). These plants live in pools and feed on water insects. The greater bladderwort (*U. vulgaris*) is not uncommon in this country, and can be found in ponds and ditches. It is difficult to see, for unless it is in flower it is entirely submerged. Its yellow flower, however, is conspicuous, as is the case with most of the bladderworts. If a plant be found and examined,

the leaves will be seen to be covered with numbers of small bladders about the size of a pea. These bladders are arranged somewhat in the manner of an eel-pot. There is a small trap-door that can easily be pushed down from outside, but it cannot be opened from within. It is, in fact, a one-way valve.



Bladderworts in a pond

In the corner is shown a magnified section of a single bladder.

Small water insects hoping to find a safe refuge push their way into these bladders. Alas for them, they cannot get out again. On the inside of the bladder are glands that excrete a digestive fluid, and the little water animals are soon killed and absorbed by the plant. The bladderworts should not be encouraged in fish-ponds, for small fry often run their heads and gills into the bladders and are suffocated. Charles Kingsley found in the West Indies bladderworts that were more like in habit to a delicate stalk of flax, or

even a bent of grass, upright, leafless, or all but leafless, with heads of small blue and yellow flowers, and carrying, in one species, a few very minute bladders about the roots, and in another none at all. He also found other bladderworts that grew on the wet moss on tree trunks, and one he found growing in the pools of water that collect in the cups between the leaf-sheaths of the bromeliad, that curious epiphyte we mentioned in the last chapter. The fact that the bladderwort considered such a pool worth its while goes to show that the bromeliad is not really insectivorous, for were it so it would kill the insects in the water, and they would never find their way into the bladders of the *Utricularia*. Consequently, though it is sometimes said that the bladderwort is stealing the nourishment of the bromeliad, this is probably a false accusation. The bladderwort is merely killing the insects that live in the bromeliad's pool, and is really doing no harm.

The toothwort (*Lathræa squamaria*) we have already referred to as a parasite. It is, however, thought to obtain some part of its food insectivorously. When, in March, it sends up its flower spikes thickly crowded with dirty white flowers, below these flowers are to be noticed a number of modified leaves. Their colour is much the same as that of the flowers, and they are formed of much curled fleshy scales. These scales contain a labyrinthic interior and can only be entered by a narrow passage formed at the tip of the leaf. It is in no way an obvious entrance, but minute insects on the look-out for a safe retreat find their way inside and lose themselves in the complicated series of chambers within, and very few of them discover the way out again. Though the toothwort is not known to excrete a digestive fluid, there are those who assert that shreds of protoplasm grow out from the cells of the plant and extract what they

A pitcher plant (*Nepenthes Rafflesiana*)

can from the insects. This they infer from the fact that scales that have been cut open contain only the hard parts of the insects. If this is so, then the toothwort has the doubtful honour of acquiring food not only parasitically from the roots of other plants, but of obtaining also an extra special dish consisting of insects.

Larger and far more important than any of the plants we have just mentioned are the various pitcher plants, the *Nepenthes* and *Sarracenia*. In the true pitcher plant,

Nepenthes Rafflesiana, hanging from the end of the long leaves there is a little up-turned vessel. These vessels are generally striped and blotched with purplish red. Together with Sarracenia, the Nepenthes is frequently grown in botanical gardens, where its unusual appearance and habits make it an object of great interest.

If we examine one of these pitchers we shall find it half full of what appears to be water, and in the water there will probably be a number of dead insects in various stages of decay. The lip of the vessel is coated with honey and to this various insects are attracted. These alight and are drawn by the desire for more honey farther and farther into the pitcher. The downward journey is made easy for them by the honey guides, similar to those in many flowers, while a return journey is made practically impossible by stiff downward-pointing bristles with which the sides of the pitcher are lined. The insect, when it has had its fill of honey, tries to climb out again but is prevented by the hairs and the general stickiness, and sooner or later it falls into the water at the bottom. Into this water the plant has excreted the digestive fluid, and the soft parts of the animal are very soon dissolved.

There are many different kinds of *Nepenthes*, some with small pitchers only two or three inches long, while others are very large. A species from Borneo described by Dr. Hooker " has pitchers which, including the lid, measure a foot and a half, and the capacious bowl is large enough to drown a small mammal or bird." More handsome than the Nepenthes are the Sarracenias. The commonest of these is the side-saddle plant from North America, which has trumpet-shaped leaves six inches to a foot long. The leaves are united along their edges to form vessels (though some botanists regard the pitchers as hollow leaf stalks)

and these vessels catch and kill the flies in much the same way as the Nepenthes. There is honey at the top of the pitcher and on a curious little lid which prevents the rain entering the vessel and possibly overfilling it, and there is also honey on the margin. As in the Nepenthes the inner sides are covered with stiff downward-pointing hairs, and the water at the bottom contains a digestive fluid.

The Indian Trumpet Leaf (*S. flava*) has pitchers three feet long and handsome yellow flowers seven or eight inches in diameter. There is also a variety that is said to have only a small entrance leading to a domed chamber in which are patches of transparent cells against which the insects dash themselves until they fall into the poisonous fluid beneath.

These insectivorous plants are not, however, immune from attack. Certain birds are said to raid them for their insects, and lemurs are known to take from the larger species of Nepenthes the dead creatures in their pitchers. Mr. F. G. Scott Elliott says that he found near Fort Dauphin in Madagascar, " great quantities of *Nepenthes Madagascariensis*. Almost every pitcher was one-third or two-thirds full of corpses, but in some of them large, fat white maggots, all of a very unprepossessing appearance, were quite alive and apparently thriving." He adds that at the same place, " a white spider was very often to be seen. Its web was spun across the mouth of a pitcher and its body was quite invisible against the bleached remains inside."

The insectivorous plants form an interesting group, and though there may be those who feel that this inversion of the usual order of things is not to their liking, we cannot but marvel at the extraordinary adaptability that has enabled the stationary plant to make war successfully on the more mobile insect.

CHAPTER XVII

Plant Relationships

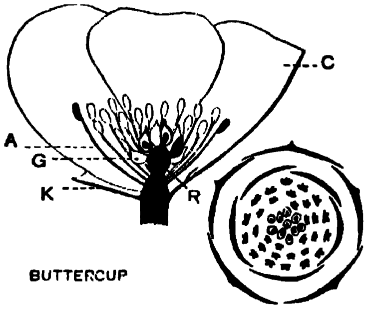
One of the joys of botanizing is to be able to go into the fields and country lanes on expeditions in search of flowers. You return from your rambles with your trophies, which, if you are wise, you have been careful to carry in a small tin collecting box provided with damp blotting-paper or moss. It is not good for them to be stuffed into your pockets, or tied to your handlebars or held in your hands. And it is very selfish and indefensible to pick more flowers of any sort than you need to provide specimens for examination or to add to your collection. I am sure you need no reminder that it is a crime to lift plants up by the roots and take them home. It is against the law. It is an extremely silly crime, because wild plants very, very seldom take kindly to garden cultivation; they almost invariably dwindle and die. It is also extremely selfish, since by such thoughtless thieving the countryside becomes robbed of a part of its natural charm.

One of the most misleading things in the study of plants is the apparent resemblance between certain species which are not related, and still more, the want of resemblance between plants of the same family. Any attempt at classification is very dangerous without an examination of the flower, for points of similarity between stems, leaves and roots do not count much with the botanist. His chief con-

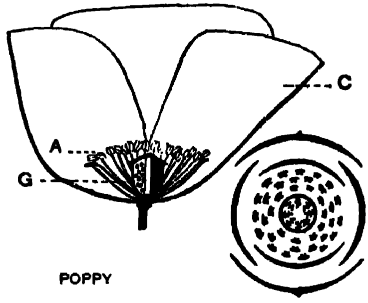
cern, when identifying the species of a plant, is the arrangement of the floral organs. The leaves and other parts of the structure are of less importance, though they often help in denoting the *variety*.

I told you in Chapter IV how the botanist divides the whole of the vegetable kingdom into two great divisions, the Flowering or Phanerogamous Plants and Flowerless or Cryptogamous Plants. To the latter division belong all the plants which reproduce themselves by spores instead of seeds—for instance, mosses, moulds and mildews, fungi and ferns. To the first-named division belong all the higher forms of plant life. Each of these divisions is sub-divided, but for the purposes of this book it is unnecessary to detail the subdivisions, which could only be done by the introduction of a lot of many-syllabled words. It will be sufficient for us here to class our flowers in "Natural Orders"—groups which embrace such plants as agree with one another in the greatest number of points. There are, however, over ninety orders of British plants alone, and we clearly cannot describe them all in one short chapter, nor would it be of very much use to learn them all. Let us take a dozen well-known plants of different orders and see what we can find out about them. So we will go out into the garden, and if we can't find what we want we will go over the wall into our neighbour's garden, or stroll down the lane to see what grows there—and pick a buttercup, a poppy, a wallflower, a stitchwort, a mallow, a sweet-pea, a wild rose, a cow-parsnip, a cornflower, a borage, a foxglove and a white dead-nettle. I think it will be rather marvellous if we find all these in bloom at the same time!

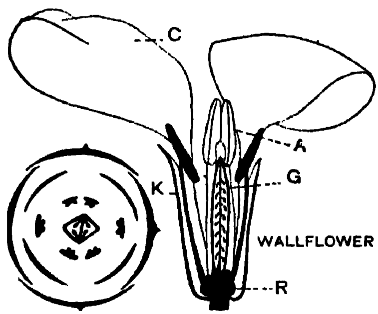
BUTTERCUP. This is the type of the Natural Order *Ranunculaceæ*. Other well-known members of this order are the anemone, clematis, larkspur, columbine and Christmas rose.



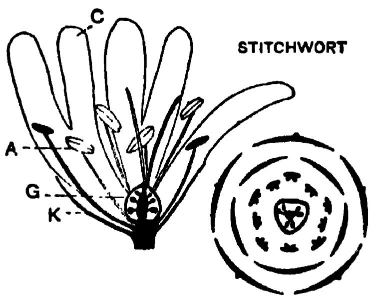
RANUNCULACEÆ



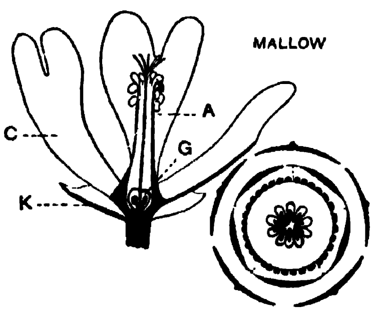
PAPAVERACEÆ



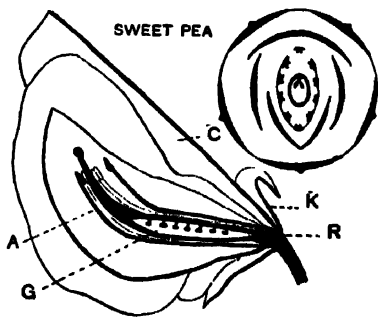
CRUCIFERÆ



CARYOPHYLLACEÆ

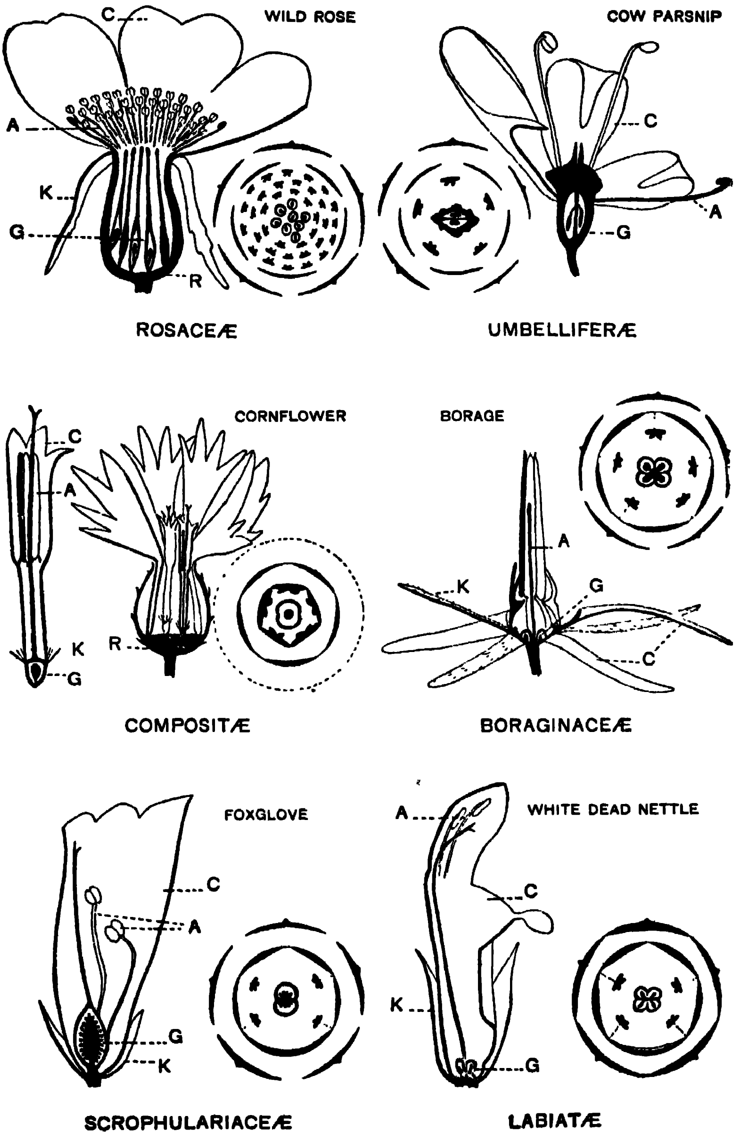


MALVACEÆ



LEGUMINOSÆ

A, Andrœcium. G, Gynœcium. C, Corolla. K, Calyx. R, Receptacle.
See also floral diagram on p. 82.



A, Andrœcium. G, Gynœcium. C, Corolla. K, Calyx. R, Receptacle.
See also floral diagram on p. 82.

None of these at first sight bears much resemblance to the others, except the anemone and Christmas rose (which evidently is not a rose at all). There are, however, resemblances between them. The first great characteristic of Ranunculaceæ is that the parts of the flower are all free. (Do you remember that word polypetalous on page 79.) Another is that all the plants belonging to this order are herbs, that is to say they are perennials which die down every year, except the clematis, which is a shrub. In many examples there are no true petals, their place being taken by a petaloid calyx. In the larkspur and columbine the petals are horn-shaped, giving the "spurs" which distinguish these flowers. In this order the leaves are very deeply cut, and the plants are poisonous.

POPPY. *Papaveraceæ.* Here is a Natural Order composed almost entirely of one kind of plant, for with the exception of the greater celandine all the members of the Papaveraceæ we meet with in England are called "Poppy", with some qualifying name such as "Iceland", "Oriental", "Horned", &c. The poppy flower is very familiar to most of us. There are only two sepals, which fall off as soon as the flowers are open. The petals are crumpled in the bud. Poppies are herbs, and secrete a milky juice. The seed-pods are very characteristic, being hard capsules with the remains of the floral organs forming a little star at the top. These capsules are filled with minute black seeds.

WALLFLOWER. *Cruciferæ.* If on our ramble we have not been able to find a wallflower or stock in blossom, a spike from our neighbour's cabbage that has "bolted" will do just as well as a type of this Natural Order. Turnip, radish, cabbage, cauliflower and Brussels sprouts all belong to the cruciferæ, which is named from the "cross-form" of its corolla. Most of the flowers have a distinctive scent—the

gillyflower scent—and all form a distinctive fruit, a seed-vessel called a siliqua, which is like a long narrow pod containing two rows of seeds. In some forms of cruciferæ the pod is flattened out, as in honesty, and is then called a silicula. These plants have six stamens, four long and two short.

STITCHWORT. *Caryophyllaceæ.* This pretty little plant is offensively described by the botanist as " a glabrous herb ". What he means is that this, and nearly all the other members of the same Natural Order, are smooth hairless plants. Pinks, carnations, campions and sandworts are all *Caryophyllaceæ*, and if you handle them you will notice their smoothness, and also that they all have swollen nodes. Their leaves are always opposite and their mode of flower-bearing is, one flower on a terminal spike with two branches below; these two branches each branch twice again, and so on. Our learned friend the botanist calls it a dichotomous cyme.

MALLOW. *Malvaceæ.* Mallows and hollyhocks comprise this Natural Order, and they are herbs having alternate leaves. The flowers present many points of botanical interest of which we need only mention two. In addition to a calyx and corolla there is an *epicalyx* of three bracts. The five stamens are joined into a tube round the pistil. The fruits are a peculiar shape and composed of many sections, each containing a seed.

SWEET PEA. *Leguminosæ.* The leguminous plants of Britain are all annuals and climbers, having alternate compound leaves and tendrils. The flower of sweet pea is typical of the whole Order, being composed of five petals; one at the back called the standard, two at the sides called wings, and two in front, closed, called the keel. The fruit is a pod. This is a very large Order. To it belong plants

which are represented in Britain by many varieties, such as all the clovers, all the vetches, and peas, gorse, broom, &c.

WILD ROSE. *Rosaceæ.* This Natural Order, with the foregoing, will provide man with nearly all the vegetable food he wants. If we add the Natural Order *Graminaceæ* he will have his cereals as well. The rose family embraces nearly all the fruits (not the gooseberries and currants, which belong to the Natural Order *Saxifragaceæ*, together with the little saxifrages of the rock garden); the apple, pear, strawberry, raspberry, blackberry, cherry, plum, &c. The spiræa is also a rose, although we should not expect that from its general appearance. Many of the members of this Natural Order are shrubs, and some are trees. The characteristic rose-flower has five petals and five sepals. The sepals are joined and the petals and stamens are around the ovary. Notice the difference between this flower and your buttercup, of which the sepals are free and the petals and stamens below the ovary.

COW PARSNIP. *Umbelliferæ.* More of our kitchen vegetables belong to this Order, including parsley, celery, parsnip and carrot. These plants have deeply-cut leaves and the flowers grow in large umbels. Each tiny flower has five sepals, five petals and five stamens, all placed below the ovary.

CORNFLOWER. *Compositæ.* Now we come to the flowers called *gamopetalous*—joined petals—and the Natural Order *Compositæ* is rather difficult to understand because it despises ordinary petals and sepals and arranges its flowers in quite a different way. Instead of a calyx it has an *involucre* of small green bracts, and instead of a corolla it has two kinds of florets, and it has no stamens. The dandelion family, which includes all the numerous hawkweeds and hawkbits, is more regular in its structure and owns both

petals and stamens. All the daisy tribe have an outer ring of ray florets and an inner ring of generally yellow disk florets. Our cornflower has an outer ring of florets which have neither stamens nor pistils and are simply there for show. The inner florets contain the usual floral organs.

BORAGE. *Boraginaceæ.* The common borage with bright blue flowers is a favourite bee plant and is often found in the gardens of old cottages. It is typical of the Natural Order to which forget-me-not and bugloss also belong. In this flower the five petals and five sepals are joined, forming a tube which is closed at the mouth by five small scales. The flowers are borne in a special way, one flower being at the top of the flower-stalk with one branch below it, bearing a flower at its tip. This branch rebranches once again, and so on, all the flowers being on the same side of the main stem.

FOXGLOVE. *Scrophulariaceæ.* Here we have another closed flower: five sepals, five petals, generally four stamens, but the number varies. The stem is square and the leaves opposite. The flowers grow on short stalks up the flower stalk. Snapdragon, mullein, and veronica belong to this order.

WHITE DEAD-NETTLE. *Labiatæ.* The lip flowers, which bear some resemblance to the two foregoing Orders. White dead-nettle has a square stem and opposite leaves, five sepals, five petals, all closed, and four stamens. The flowers grow thickly on short stalks in the leaf axils.

If you are in any doubt as to whether specimens which you find should be classed as *Labiatæ*, *Scrophulariaceæ* or *Boraginaceæ*, you can always satisfy yourself by comparing the fruits and leaves.

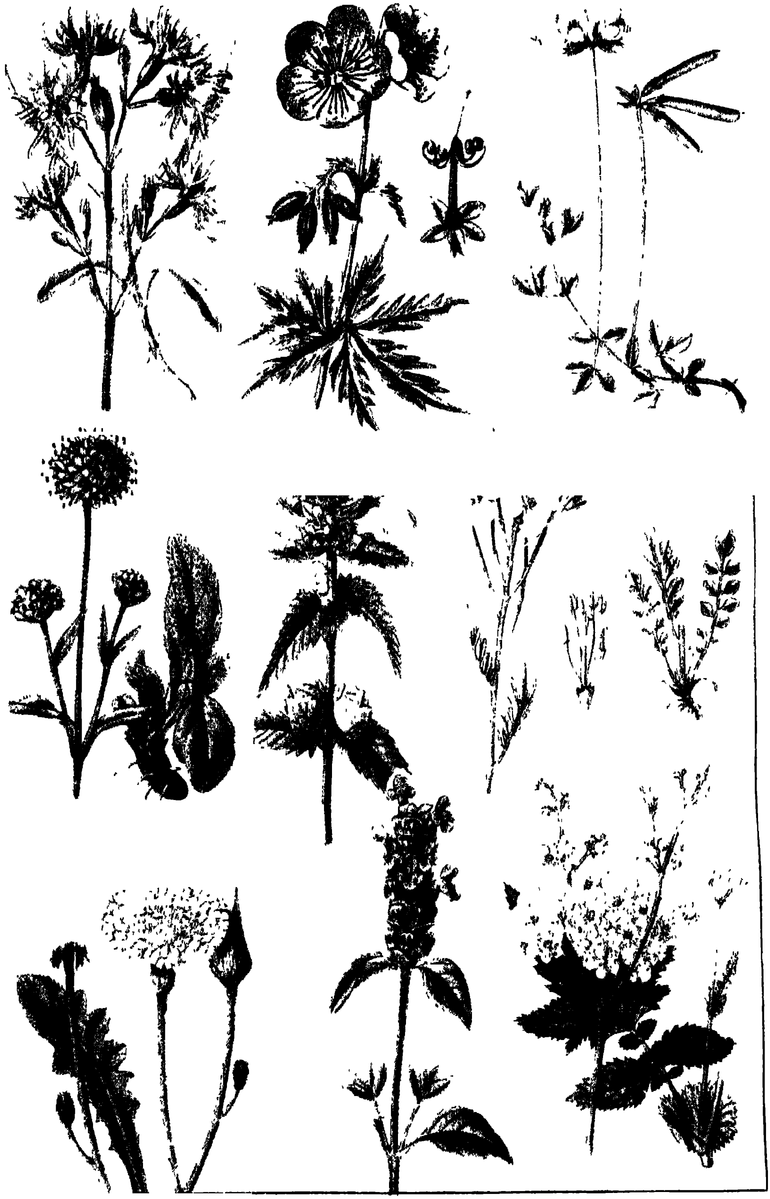
Labiatæ has fruit in four nutlets, leaves opposite. *Scrophulariaceæ* has fruit in a capsule, leaves opposite. *Boraginaceæ* has fruit in four nutlets, leaves alternate.

CHAPTER XVIII

Plant Life of the British Isles

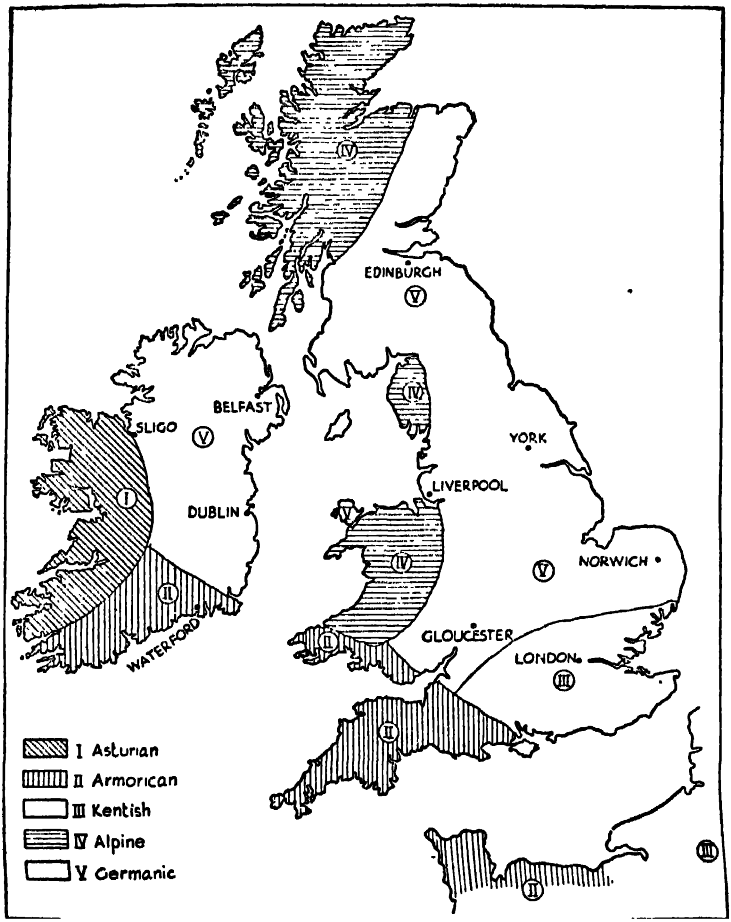
It is usual to regard the vegetation of the world as distributed in belts of heath, forest and grassland. The limits of these belts are fixed by conditions of climate, and the plants in each belt have similar characteristics all the world over and for similar reasons. It might be supposed that in a small country like Britain there could be very small variation in the flora, since in a distance of seven hundred miles or so no one of these three great belts could be traversed. Broadly speaking that is true. We have in Britain no regions of intense heat or intense cold; no deserts, no swamps. But we have a little of everything on a very small and temperate scale. We have in the north-east a region in which trees will not grow, and in the south-west a climate warm enough for palms and cacti. We have rocky mountains devoid of all but the meanest of vegetation, and stretches of thin soil, such as the Breckland of Norfolk, the heaths of Dorset and Hampshire, where only a very few plants can subsist. We have sandy soil, chalky soil, rich loams, wonderfully fertile river valleys—sandstone, limestone, shale, volcanic earth and sedimentary earth of many kinds. And we must not forget that the face of this little bit of the world we call Britain has changed again and again since first it appeared as dry land.

This being the case, we must expect that the vegetation



BRITISH WILD FLOWERS

Top row: Ragged Robin, Meadow Crane's Bill, Bird's Foot Trefoil. *Middle row:* Devil's Bit Scabious, Yellow Rattle, Lady's Smock. *Bottom row:* Long-rooted Cat's Ear, Self-heal, Meadowsweet.



Map showing the distribution of flowering plants in Great Britain and Ireland

must share in the differences of the soil that nourishes it. So definite are the characteristics that if you are taking a long railway journey and fall asleep, you can tell, by looking out of the window on awaking, what part of the country you have reached, by observing the nature of the fields and

landscape flying past you. For one of the charms of Britain is the great variety of its countryside, and that has been brought about by its remarkable geological history. We know that the political history of our country has much of incident and romance, but its geological history is stupendous. Volcanoes, glaciers, seas, lakes, mighty rivers—as well as the slower influences of weather—all have had a part in carving its surface and leaving accumulations of soil of different kinds, with here and there a bare rock face sticking out and defying all the elements. The volcanoes threw up great mountains; millions of years later the glaciers scraped them down again, and in scraping carried away stores of finely-ground rock to form soil at lower levels. The rains and winds beat upon the uplands age after age and smoothed away their ridges and angles, and carried away much fine dust in the process. The rivers dredged the level lands, digging for themselves deeper and deeper beds, and leaving banks of sand and silt whenever they chose to change their courses. Where they ran the country became diversified in contour, for as they deepened the valleys, of necessity the hills around them became higher above the surrounding plain. The winds and rivers did something besides carrying the dust and soil from high lands to low. They carried seeds, so that wherever a small patch of bare earth appeared, there would green things germinate and grow. And by their growing and dying and restoring to the soil all that they had taken from it and more, the plants enriched it and bound it firmly into a strong root-hold for their own descendants.

This little country is divided into regions of widely differing geological structure. You must bear in mind that not so very long ago (geologically speaking) the British Isles were still a part of the continent of Europe, which

means, in fact, that they were part of the great earth block forming Europe, Asia and Africa, over which all kinds of animals could roam in search of their food supply. Seeds of plants are continually being transported from one place to another in the coats of animals and this is one explanation of the wide distribution of certain plants. Devon and Cornwall were united to France and the similarity of people and language still to be traced from Brittany through Cornwall to South Wales and Southern Ireland is a legacy of this union. We would expect to find also a similarity of plants in those districts. The south eastern corner of England has a flora of the same kind as the opposite Continental countries—France and the Low Countries, while that of central, eastern and northern Britain and north-east Ireland resembles the plants commonly found all over northern Europe. But the west of Ireland looks to Spain to find its complementary flora. There is only one remaining class of plants to refer to, and that is the flora of our high grounds, in Wales, Cumberland, and the Highlands of Scotland.

Definite names have been given to these distinct classes of plants by a naturalist named Edward Forbes. He named them as follows:

1. Asturian—Western Ireland. Spain.
2. Armorican—South-west England and south-east Ireland; Channel Isles and opposite coast of France.
3. Kentish—Kent, Essex, Berks, Wilts, the counties surrounding London (" The Home Counties "), Sussex and Hants, and the opposite coast of France.
4. Alpine—Northern Scotland, Cumberland, Wales, Norway, the Alps and Vosges, Lapland, Iceland.
5. Germanic—North and east Ireland, all of England and Scotland, except the parts mentioned above, and more or less the whole of Europe.

These divisions, it will be seen, are of the broadest kind. We cannot suppose that it is possible to divide the plant life of a country into strict reservations, beyond which no member may stray. Neither is it possible, in a country of so varied a geological history as Britain, to avoid a certain amount of overlapping. For instance, the division named "Kentish" contains many different geological formations, some of which we shall find again in the other divisions. For while Essex is largely reclaimed river mud, Kent is ringed around with chalk; the central part of the county —the rich Weald—being again river mud. Surrey and part of Hampshire on the other hand are sandy, while Sussex is chalk again. All of these formations we shall find under the heading Germanic. Similarly the section called "Alpine" is—as far as England is concerned—alpine only in its higher altitudes. The valleys have varying vegetation according as whether limestone or shale predominates. As to the Germanic Section, it covers so much widely-differing country that we can be sure that we shall meet there some plants whose acquaintance we have made at other times. For in the Midlands and the Fens we have more reclaimed river mud; on the Yorkshire coast we have chalk cliffs again, and in the lowlands of Scotland there is still ground high enough to carry an alpine flora. And we may be sure that in the limestone and granite heights of the Armorican Section we shall find alpine plants.

In studying the flora of a country there are many factors which we have to consider. There is soil, due to geological foundation such as we have already glanced at. There is climate, with which is associated the factor of altitude, for even in the tropics you may find Arctic flowers if you go sufficiently high above the level of the sea. There is water-supply and situation—that is, aspect, and the absence or

prevalence of natural enemies. In the widest application this study is called plant geography—phyto-geography; but the science of plant-life in any one locality is called ecology. It is obvious that the broadly different types of country, i.e. woodland, pasture and heath, may be subdivided many times. Let us arrange them in tabular form:

Woodland

Evergreen.	Deciduous.
Mountain pine, pines of sandy soils.	Beech, oak, birch.

Pasture

Waste places in cultivated land.	Cultivated meadow-land.	Limestone pasture and downs.

Pasture (*cont.*)

Hedgerows.	Roadsides.

Heath

Bog.	Sandy heath.	Marsh.

Aquatic plants

Immersed.	Floating.	Inundatal.

And in addition to these there are the plants of mountains and the seashore.

Now, the question of situation and aspect is very important. We are accustomed vaguely to think that the north is cold and the south is warm; that a hilltop is bleak and a valley sheltered. But climate is not as simple as all that. In the British Isles the coldest region is towards the east. All the east coast confronts the cold winds from the North Sea, and is at once the driest and coldest part of the kingdom. Further west, whether north or south, the air becomes softer, moister and warmer. Thus many plants are hardy in the western highlands of Scotland which will not stand a winter at Kew, near London. In the same way a hillside

facing south or south-west protected on the north and east by belts of trees or by higher hilltops may be a very pleasant place indeed; while a valley facing north and hidden from the sun by hills on the south and west can show remarkably high frost figures, even in the south of England. Differences in soil, moreover, make a surprising difference to the warmth supplied to the plant life. A dark-coloured soil absorbs heat much more quickly than a light-coloured one, and this is one of the reasons why soot is useful when applied to light-coloured soils. It darkens the soil, making it a better conductor of heat. We speak of a " hot " sandy soil, and a " cold " clay soil. The sandy soil has little humus or fibrous substance. As I told you when we were talking of soils, the particles are so coarse and angular that the water held between them is very soon evaporated, causing the plants to wilt. The clay soil, being to a certain extent impervious to water, bears its plants on a sticky, watery surface; waterlogged in damp weather and hardened to a cake in dry weather. There is much clay soil in the Midlands, which, as the poet says, " are sodden and unkind "—the water stands about and chills the roots of the plants, checking their growth. So you see it would be quite unwise to put your finger on any spot of the map of Britain and say: " Such and such a plant will grow—or will not grow—on this latitude." You will have to learn all about the soil and aspect and altitude of the place before you can give a reliable opinion.

But, to make an end of this chapter, the ultimate and vital need of plants is water supply. We are inclined to think of these islands as rainy places where there is always too much water, and never a scarcity. Yet this very November morning, before I began to write, I saw in my paper these words: " Scarcity of water in Bristol. Appeal for reduced con-

sumption." The paragraph refers to an unusual drought since March. But those of us who live in the country know to our sorrow that there are comparatively few years during which there is not a long enough spell of dry weather to cause anxiety to those householders who have to depend upon wells for their water supply. In fact, the attitude of the Englishman towards his water-supply is typical of his attitude towards many things: England is a damp country, therefore we shall never be short of water. How far from the truth this is may be proved in almost every rural district nearly every year.

CHAPTER XIX

Flowers of Meadows and Fields

When one first begins the study of wild flowers, one is tempted to say: "Why must I bother about these awful names?" It is quite true that botanical names present a real difficulty to a young student, and all too often they give him a distaste for botany which is never overcome. The familiar names for plants are so easy and seem much more suitable for homely or insignificant little flowers than many-syllabled Latin names which are troublesome to remember. But botany is a science, and science, we must remember, is an exact ordering of facts. Science allows one name, and one only, for each little plant of the field or hedgerow, however small and apparently useless it may be. Many of the names of plants were given to them centuries ago by herbalists who ascribed to every plant they used some particular virtue or vice. The study of herbs was very complicated, being linked up with the mysterious and now wholly exploded "Doctrine of Signatures". This was the belief that plants, and animals too, bore certain marks which were ordained by Providence to show what diseases they could cure. These marks were principally identified with the signs of the stars, certain plants being governed by certain stars according to the rules of astrology. Other plants bear characteristics—often quite fanciful—which have some resemblance to various organs of the body; for instance, the little plant euphrasia, commonly called eye-

bright, received its name from the little black spot, resembling the pupil of the eye, to be found on its petals; and it was used to make an eye-wash. " Like to like " was often the prescription of the herbalist—a yellow juice to cure yellow jaundice, a red juice to cure smallpox, and so on. In this way it is easy to see how several quite distinct plants might be given the same English name, for if we remember that the syllable " wort " is used to denote a cure, and " bane " as a destroying agent, the multiplication of names of a similar nature becomes inevitable. Apart from medical names, the pretty country names of flowers are very loosely applied. I have in my possession a book of British Wild Flowers in six volumes, and in one volume alone the name " batchelor's buttons " is applied to eight different flowers, and the name " king-cup " to three, so that it is obviously impossible to use such names with any degree of accuracy. But in ordinary speaking and writing, one makes use of the commonest names, because to refer to the dear little pink-tipped daisy as *Bellis perennis*, or to the glowing dandelion as *Taraxacum officinale*, savours of a very unpleasant priggishness and self-importance. The idea is to know both English and Latin names, but to use only the most familiar.

This chapter is headed " Flowers of Meadows and Fields ", which we may take to mean the meadow cultivated for hay, and the ploughed land cultivated for cereals, roots, clover, &c. In these conditions the wild flowers, I am afraid, must come under the description of weeds, for they are undoubtedly " flowers in the wrong place ". Many of them, indeed, are harmless weeds, shallow-rooted and soon over, but some are definitely noxious, sending great tap-roots down into the soil and eating and drinking the nourishment required by the crops; and scattering myriads

of seeds to carry on their bad work. Such weeds are the bane of the farmer and gardener, and it is rightly made a legal offence to allow them to grow. In this and the subsequent chapters we will glance at some common flowers of our countryside.

LESSER CELANDINE. *Ranunculus ficaria.* One of the earliest to bloom of wild flowers, loving rather damp meadows, hedges and banks. We look eagerly for the glossy yellow flowers, rising from a rosette of heart-shaped dark-green shiny leaves, which may often be found in February. It flowers freely until May. This is one of the flowers called king-cup. Three sepals, eight or nine petals.

LADY'S SMOCK. *Cardamine pratense.* A water-loving plant which we may often find in damp meadows in April and May. It is rather a tall untidy plant (one to two feet), but the charm of its lilac and white blossoms growing in clusters at the head of the stalks more than compensates for its " legginess ". The stalk rises from a rosette of radicle leaves, the flower-stalks having opposite leaflets. The plant has many other names, cuckoo flower being one of the commonest.

DAISY. *Bellis perennis.* This, of course, is the flower we all know and love the best, in spite of its commonness. It seems absurd to give any description of the daisy, but as it is the type of all the flowers of the Natural Order *Compositæ* we may examine its structure. The white part of the flower, the *ray* as it is called, is attached to the yellow part, the *disk.* Thus we have two sets of *florets*, the ray florets and the disk florets, performing the work ordinarily performed by petals; that of making the flower attractive. If we examine one of the yellow disk florets we shall find that it is a little tube having five lobes to its mouth. Two of these lobes are developed tremendously and coloured

white; they form the ray florets. The little green cup supporting the flower is not a true calyx but a ring of bracts; all that there is of a calyx being a few hairs. Some members of the Compositæ provide their seeds with "clocks" or wings to help their flight to new quarters, and these hairs of the true calyx develop into such clocks. It is worth while to study a daisy head, both in flower and in seed, to see how it is constructed. Each little disk floret contains stamens and a pistil, for making seed.

DANDELION. *Taraxacum officinale.* This noble fellow is another member of the Natural Order *Compositæ*, and exemplifies perhaps better than any of his relations the formation of a "clock". The flower heads are so gorgeous it is a pity he has to be regarded as a noxious weed, but his long tap roots go down, down into the earth, making him most difficult to eradicate, while the highly-efficient wings carry his seeds near and far. It is, however, a useful plant. The blanched leaves make a salad, and in France and Germany the roots are eaten, either raw or cooked. Its descriptive name *officinale* signifies that it is—or was—used in medicine. It comes into bloom early in the year, indeed, it is seldom that one cannot find a dandelion flower.

COWSLIP. *Primula veris.* Here is another herald of spring. The cowslip is an accommodating plant in that it will grow on low ground or high, in shade or sunshine, but it is by no means general in its habitat. Whole counties in all parts of Great Britain are shunned by the cowslip, with no apparent reason, but where it chooses to grow, it grows with all its might. The funnel-shaped yellow flowers, growing in a cluster at the top of a grey-green stalk, are amongst the most beloved of our spring wild flowers, and are familiar to most people. The leaves, growing in a rosette, resemble those of the primrose.

Upright Meadow Crowfoot. *Ranunculus acris.* As the year passes from spring to summer, the meadows are agleam with this tall buttercup. The crowfoots are a very large family, and the simplest way of distinguishing between them is by examination of the roots. The upright meadow crowfoot has a fibrous root, but is distinguishable from its relations by its great height—often three feet. As it is disliked by cattle (as are all the buttercups), it remains standing above the cropped grass and is very conspicuous. The leaves which cluster at the root are very much cut and divided, but those on the stem are smooth and narrow. Sepals, five; petals, five.

Meadow Crane's Bill. *Geranium pratense.* This is a very beautiful, but rather rare flower, growing in moist situations. It is rightly considered worthy of a place in the flower garden, and grows freely under cultivation. The leaves grow on long stalks and are very deeply cut, the large bluish-purple flowers standing erectly above them. The five petals are markedly veined, the veins being Nature's signposts to insects seeking honey. The beak-like appearance of the seed-pod has given the plant its name of crane's bill, which it shares with many other members of the geranium family.

Clover. *Trifolium.* There are several different varieties of clover to be noted in the fields, where the round heads of small clustered flowers are well known. These plants are so extensively grown for fodder that the seeds have become widely distributed, and either the red clover (*Trifolium pratense*) or the Dutch (white) clover (*T. repens*) may be found in almost any patch of ground, whether field, garden or arable. The red clover has been grown in England since 1645. It is about twelve inches in height, the leaves arranged in leaflets in threes—the four-leaved clover is proverbially rare. The white clover is a much smaller plant, rarely

exceeding a height of three inches, but the stalks creep about on the surface and grow so rapidly that one season's growth may cover a square yard of ground. This is the clover beloved of bees, the honey of the red clover being inaccessible to hive bees. The flowers are white to begin with, but after pollination has taken place they turn chocolate brown from the base upwards.

HOP TREFOIL. *Trifolium procumbens*. This plant somewhat resembles the foregoing, but with marked differences. It is taller and has an erect habit, but spreads in the same way by trailing stems. The flowers are bright yellow and smaller than the clovers. But whereas the clover stalks spring from a common base, and the leaves are marked with a white or purple blotch, the trefoil leaves are plain green, carried on short stalks springing from the main stem. In fact the plant adopts a form not unlike that of the hop from which it takes its name.

BIRDS' FOOT TREFOIL. *Lotus corniculatus*. This plant does not resemble the clovers at all. The leaves comprise three leaflets, very much smaller than the clover leaflets, but the flower is an umbel of five to ten much larger lipped florets, of a brilliant gold tinged with red, borne on a long erect stalk. The plant flowers all through the summer, preferring dry, sunny situations, all over the British Isles. Its wide distribution and the shape of the florets have resulted in numerous local names, some having their origin in its colour, as Butter and Eggs, Butter-jags, Cheesecake and Eggs and Bacon; and others in the shape of the florets; as Boots and Shoes, Cats' Claws, Fingers and Thumbs, Fingers and Toes, Lady's Slipper, Pigs' Pettitoes; while the name, Lady's Cushion, obviously refers to the fluffy seed-pod.

MEADOW SWEET. *Spiræa ulmaria*. This is another plant

which loves the moister parts of meadows equally well with the ditch or stream side. It is a tall plant, the furrowed stems bearing sharply-lobed leaves of three to five segments, and at the top a " cyme " of fluffy sweet-scented, creamy-white flowers. The buds, like hard round knobs, are frequently red, giving a pleasing touch of colour to the flower heads. The second part of the Latin name, *ulmaria*, is derived from *ulmus*, the elm, because the leaf of this plant has a certain resemblance in texture to that of the elm. It flowers nearly all the summer, being often found in bloom as early as May and as late as October.

CINQUEFOIL. *Potentilla reptans.* The Potentilla family comprises a great number of plants of similar characteristics. They belong to the rose tribe and the flowers are all of the simple rose shape, five petalled. In many cases the leaves are strawberry-like and creeping, with more or less erect flower stalks. In the case of the cinquefoil, its leaves are composed of five leaflets from which the plant receives its name. The flower stalks are short, but may reach six inches in height. The stems trail about, rooting every few inches. The yellow flowers are borne singly. It is fond of dry, sunny situations, a sandy soil being its favourite.

GREAT BURNET. *Poterium officinale.* A handsome plant found in hayfields, two to three feet tall. The flower heads are like elongated purple knobs, on the summit of almost leafless stalks. The dark-green toothed leaflets are arranged on opposite sides of the stalk, generally four pairs and one at the top. Its presence in the hayfield does no harm as its leaves are wholesome and nourishing for cattle. As the Latin word *officinale* denotes, it was formerly used in medicine.

WILD CARROT. *Daucus carota.* The carrot of our kitchen gardens has been derived from this widely dispersed wild plant. The foliage is dark green and fern-like, resembling

that of the cultivated carrot. The flower stalks are tall and erect, having simpler forms of leaves. The flower is one of the many white umbelliferous forms; an umbel, as you know, being florets on separate stalklets forming a flat flower head. But in the case of the wild carrot there is something to help us in distinguishing its variety. Every umbel has a bright-red flower in the centre. Each umbel, moreover, is at first cup-shaped, flattening out only as the flowers develop. On this account some of its local names are Bees'-nest, Birds'-nest, or Crows'-nest. The stem of the wild carrot is solid, whereas in most umbellifers it is hollow.

DEVIL'S BIT SCABIOUS. *Scabiosa succisa.* The flowers of the scabious family are frequently called "pincushions", because the anthers protruding from the soft mass of the flower head give it that appearance. The wild scabious is always purplish-blue, darker or lighter according to soil and variety. The leaves are smooth and lance-shaped. This particular variety of scabious can best be identified by its root, which ends abruptly as though it had been bitten off —hence the name.

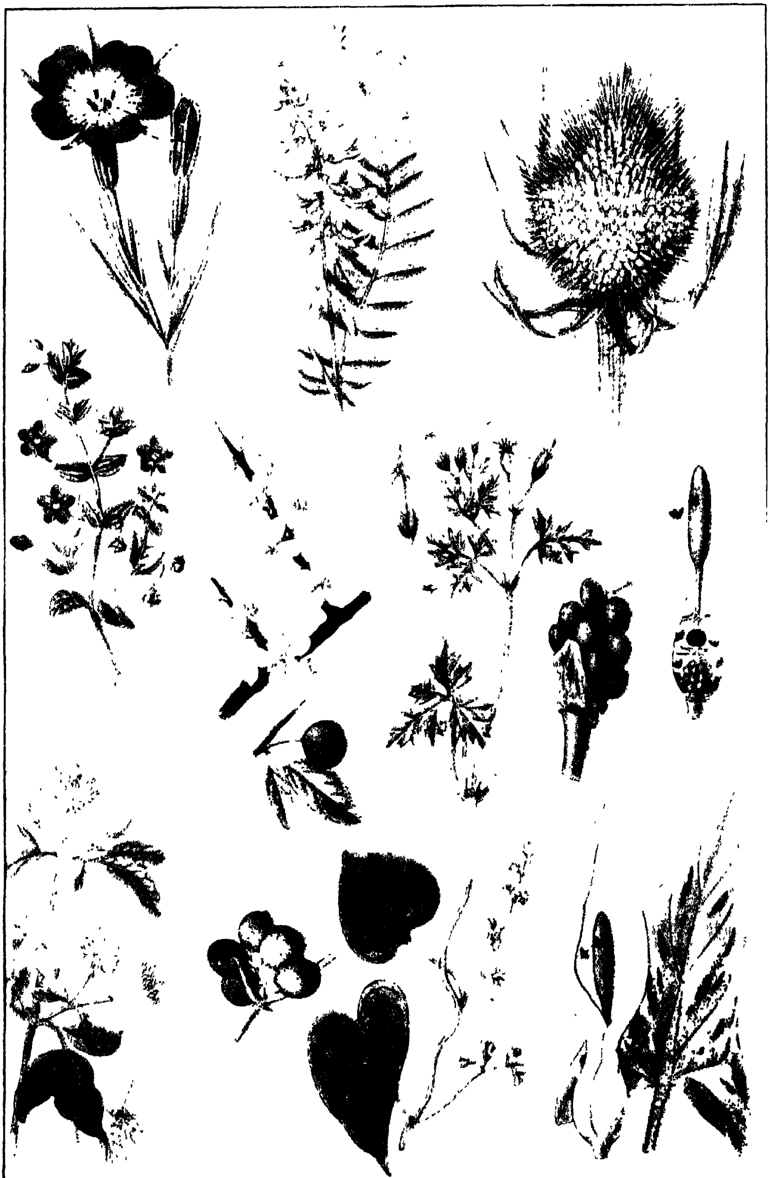
MILFOIL, OR YARROW. *Achillea millefolium.* Though primarily a sand-loving plant, milfoil is found growing in most meadows, pastures, roadsides and banks—in fact, almost anywhere. The leaves are dark green, narrow and fern-like, while the flat head of white flowers, called a "corymb" at the top of stiff eighteen-inch stems, is very conspicuous. This plant belongs to the Natural Order *Compositæ*, so we shall find that the flowers composing the corymb are of two kinds, disk florets and ray florets. The ray florets are white or pale pink, the disk florets slightly yellow. Milfoil (Latin, *mille*, thousand, and *folium*, leaf, referring to the finely-divided leaves) has a fusty smell and

is not a pleasant plant to pick, but was formerly much used by herbalists as a cure for ague, or for colds and fevers.

OX-EYE DAISY. *Chrysanthemum leucanthemum.* The well-known Marguerite daisy, with its shining white yellow-centred flowers, two inches across, comes not singly but in thousands to brighten the fields and meadows of summer. The ox-eye daisy is eaten by horses and sheep, but cows will not touch it, and the farmer may well be distressed by the mocking faces of the flowers thronging in his hayfield. In its own place, however, as a wayside, waste-place and railway cutting flower, the ox-eye has no rival during June and July. It is common throughout Great Britain on all sorts of soils, but is pre-eminently a sand lover. The stems, having few leaves themselves, spring from a rosette of dark-green bluntly-cut leaves.

KNAPWEED, KNOBWEED OR HARDHEAD. *Centaurea nigra.* Another common plant of the meadow, a very stiff, wiry plant of which the stems end in unpromising brown knobs covered during the flowering season with a purple down. It is a tall plant and flowers from June onwards into the late autumn. This plant is a troublesome weed in many places and has now nothing to recommend it, though it was used in medicine to some extent in the Middle Ages. The lower leaves are angular and divided, but the leaves on the upper stalks are simple and egg-shaped.

CAT'S EAR. *Hypochœris radicata.* Both this plant and the one following (goat's beard), and also the hawkweed and hawksbeard, are easily confused with one another, and the flowers of all are pale likenesses of the dandelion. It is found in meadows and in waste places. It has a long white milky root and the leaves form a rosette, but can be distinguished from dandelion leaves by being hairy, and not such a glossy dark green. The stems are taller than



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BRITISH WILD FLOWERS

Top row: Corn Cockle, Tufted Vetch, Teasel. *Middle row:* Scarlet Pimpernel, Blackthorn, Herb Robert, Berries and section of spathe of Lords and Ladies. *Bottom row:* Travellers' Joy, Black Bryony, Lord and Ladies.

dandelions and branched, two or three flower heads being borne on each main stem, whereas the dandelion stem never branches. The yellow flower heads are encased in a protective green cup, and they form a " clock " when the seeds are ripe.

GOAT'S BEARD. *Tragopogon pratense.* Like the foregoing, goat's beard grows in meadows and also in waste places, but it is distinguishable from cat's ear because its leaves do not form a rosette but are narrow and smooth and sheathe the stem. Moreover, the flower closes not later than midday, the most likely time to find it wide open being midnight or early morning. This habit has given rise to many of its local names, such as Shepherd's Clock, Go-to-bed-at-noon, Noontide, Sleep-at-noon, &c. The flower heads resemble the dandelion, but have a slightly greenish tint in the yellow, and they form an even larger clock. It is cultivated in France and Germany for the sake of the root, which is cooked like salsify—or carrot—but it is not used in Great Britain.

YELLOW RATTLE. *Rhinanthus crista-galli.* Here we have a very different kind of plant; one belonging to the Natural Order *Scrophulariaceæ.* It grows freely in low-lying or badly-drained meadows, and its spikes of yellow flowers are conspicuous in July and August. To the farmer it is a sign of poor ground. It has a square, erect stalk, spotted with black or brown, having opposite leaves deeply notched and stalkless. The globe-shaped flowers are carried on very short stalklets at the head of the stem, any number from six upwards forming a spike. As the seeds develop the flower closes up, and when the spike is shaken the ripe seeds can be heard rattling in the pod—hence the name rattle, or rattle-boxes. In some parts of the country it is called locusts.

SELF-HEAL. *Prunella vulgaris.* This is a labiate or lip-

flowered plant, to be seen in most meadows. It is a short, hairy plant, the rootstock creeping, the leaves egg-shaped and smooth-edged. The dull purple flowers are borne in thick whorls at the top of the stalk, a pair of bracts always occurring at the base of the flower head. All through the summer these purple-blue spikes are a common feature of poor meadows on clay soil.

PURPLE ORCHIS. *Orchis mascula.* Orchis is a name applied to a genus containing ten British orchids. It is a Greek word applied to plants having a tuberous root. This particular specimen is a woodland plant, but is sometimes found in meadows that have been cultivated out of woodlands. Its habit is the same as that of most British orchids; erect stem, rising from sheathing leaves, bearing a loose spike of flowers. The leaves are smooth and pointed. The purple orchis has large deep-purple flowers, and the leaves are spotted with purple. But the usual purple orchid found in meadows is a smaller plant called the green-winged orchis (*Orchis morio*). The commonest of British orchids is the spotted orchid (*Orchis maculata*) which abounds in damp meadows and damp places everywhere, having pale lilac flowers spotted with purple, and spotted leaves. All these are flowers of late spring and early summer.

CHAPTER XX

Flowers of the Hedges and Ditches

This double classification is almost a contradiction in terms, since hedges are commonly raised banks providing good drainage for their plant life, and ditches, in the nature of things, are moist and shaded. But the plants of each kind become so intermingled that it will be convenient to study them together. The first thing which will strike us, when we begin to examine the vegetation of the hedge and ditch —even those bordering a main road—is the infinite variety of plants crowded at the base of the hedge; and also the number of different species actually forming the hedge or rambling over it. Of course, to show its best results your hedge must not be too tidily cut and trimmed. Hedges that are smooth and symmetrically shorn on both sides and the top may provide a testimonial to the hedger, but they will offer fewer specimens to the collector of wild plants. To be seen at its full glory the hedge must have remained untrimmed for at least three years, so that the young wood of ash, cornel, maple and thorn can bear a proud show of leaf and blossom and fruit. The bank also must be given opportunity for self-expression if we are to find all the treasures possible for it to produce.

The hedge itself will probably include many forest trees; for instance, elm, oak, beech, ash, maple, holly, sycamore and lime. But there are a few trees which are more definitely

placed as hedge trees, and we will take note of them in this chapter.

It must be remembered that, as hedges often border gardens, or the sites of gardens since neglected, the types of plants known as " escapes " may often be found there. For instance, I was once puzzled by the existence of some large bushes of *Leycesteria Formosa* in a hedge which showed no signs of cultivation. But on searching the ground behind, I came upon the foundations of a cob cottage, hidden under a mat of grass, and the mystery was solved. Similarly, plants may seed from gardens at some distance away, and by a happy chance survive in hedge or roadside.

BARBERRY. *Berberis vulgaris.* This is a shrub which was formerly cultivated for its fruit, which, though acid, can be made into an agreeable jelly; and for its bark, which, being yellow, was considered according to the Doctrine of Signatures to be a cure for jaundice. But it is now a forbidden tree, as it was discovered to be a host for the disease of smut in wheat, and where it is found now it must be regarded as wild. The Barberry is erect, smooth-stemmed, of a shrubby habit, the upper boughs overhanging causing a pretty effect both when the racemes of yellow flowers and the clusters of long scarlet fruits are to be seen amongst the leaves. The stems are provided with very sharp spines, and the egg-shaped leaves are finely toothed. The flowers are like little golden globes, being composed of six petals curled inwards at the tips. These ultimately open wide. About twelve flowers usually make a raceme, and they ripen into brilliant wax-like berries.

WINTER CRESS. *Barbarea vulgaris.* Similar though this name may be with that of the foregoing, there is no similarity in the plants. Whereas the name Berberis is of uncertain origin, Barbarea refers to Saint Barbara whose

festival was kept on 4th December, and since winter cress was used as a winter salad it was called Saint Barbara's herb. It may be described as a ditch plant, and generally chooses a slightly moist situation. It is tall and straight with an angular stem crowned by branching heads of tiny yellow flowers in loose racemes. It blooms from May to August, and, as it is a member of the Brassica or cabbage family, the flowers are all followed by the narrow seed-pods of the kind called a siliqua. The lower leaves are rounded, but the upper may be toothed. The undersides are often purplish in colour, and glossy dark green above.

HEDGE MUSTARD. *Sisymbrium officinale.* As commonly seen, this is one of the least pleasing of Flora's efforts, and it seems to thrive best on waste ground, and dry patches generally. It has a strange affinity for dust and presents a dingy appearance which it has no beauty or grace to relieve. It is an annual, and in its early stages simply appears as a compact plant having a hairy purplish stem and crowded leaves deeply cut and divided. Then suddenly it thinks of flowering and sends up numerous wiry stalks, devoid of leaves, bearing at the top three or four tiny yellow flowers. It then becomes a plant of spidery and repulsive aspect.

SAUCE ALONE, *Sisymbrium alliara*, is an improvement on its relation, the plant previously described. Its glossy, heart-shaped leaves are alternately arranged on the stem right up to the flower heads, and smell slightly of garlic when rubbed. The flowers are small and white, growing in a cluster at the top of the stalk. Another name for this plant is " Jack by the Hedge ".

GREATER STITCHWORT. *Stellaria holostea.* In the spring-time our hedges are adorned with one of the most beautiful of wild flowers, and in all the temperate countries of Europe and Western Asia, Flora in her bounty allows the same flower

to gladden the eye. Few people indeed can have failed to see the white, star-like flowers of *Stellaria holostea*—or, to mention but a few of its many local names—Starwort, Easter Flower, Lady's White Petticoat, Satin Flower, Milkmaid, Pixy, Thunder Flower, and, of course, Bachelor's Buttons. The name stitchwort denotes its use in medicine in former days, the plant being steeped in wine to be drunk for a pain in the side. It likes a soil rich in leaf mould, or peaty loam, and a semi-shaded position. Here it will flourish, its grass-like stems with swollen nodes and long narrow leaves, being difficult to distinguish from the true grass, until the buds and flowers appear in April. The flowers are satiny white, having five petals divided almost to the base, carried on slender stalks. The stamens are purplish and make a little dark star in the centre of the flower.

PERFORATE ST. JOHN'S WORT. *Hypericum perforatum.* An old name for this plant is Balm of Warrior's Wound, and the leaves were boiled in wine as a cure for cuts. In this species of Hypericum the leaves have tiny holes, which by the Doctrine of Signatures would imply that they would heal wounds. It is a tall plant, eighteen inches high, and blooms freely along the roadsides from July to September. The root sends up a cluster of stems, having opposite branches, and small stalkless leaves of which the undersides are covered with black dots containing oil. The glossy yellow flowers have five petals and five sepals, and three bundles of stamens.

HERB ROBERT. *Geranium Robertianum.* This very common little plant with a nasty smell is one of the prettiest occupants of the hedge-bank, and its flowers may be found during the greater part of the year. It has a straggling habit, as many a gardener knows who has had to pull its runners out of his flower-beds. The stems are red and hairy, constantly

branching. The leaves are made up of three to five deeply-cut lobes, fern-like. The five-petalled flowers are magenta, and give place to long seed-pods, from which one of its names—stork's-bill—is derived.

SPINDLE-WOOD, *Euonymus europæus*, likes a slightly moist and shady situation. It is a small tree—or large shrub—not very often found, or, perhaps, it is more true to say that it is not very often noticed, for the leaves are dark and inconspicuous, and the tree has no particular grace of form. Its beauty comes with its fruit, and that, all too often, is cut by gypsies on its first appearance and carried into towns for sale. Spindle makes a very hard wood which can be turned for skewers and "spindles" and bored for pipe-stems. The trunk is somewhat squared, covered with a greenish bark which turns greyer with age. The flowers, to be seen in May and June, are greenish-white in an umbel springing from the leaf-nodes and are not very noticeable. The leaves begin to thin out at the end of the summer and reveal the beauty of the ripened seed, a crimson capsule enclosed in an orange cup.

TUFTED VETCH, *Vicia cracca*, also known as tare, is a plant of lanky straggling habit, always seeking the support of some tougher-stemmed neighbour. But we should be sorry to miss its racemes of purple labiate flowers from the banks and hedgerows, where it makes a pretty display all through the summer. The stalks and leaflets, which are lance-shaped and opposite, in ten pairs, are all of a downy grey-green, and the strong tendrils clutch and twine wherever they can reach. The flowers are long tubes, slightly drooping, arranged in twenties or thirties at the head of the stalk. tufted vetch likes a sandy loam, but is accommodating in the matter of soil.

MEADOW VETCHLING. *Lathyrus pratensis*. Here is another

semi-climbing vetch, which, having yellow flowers, makes a pleasing contrast with the tufted vetch; but it is also found in moister conditions than those required by the tufted vetch. It is a slightly hairy plant; the leaflets being in pairs only. The flowers grow in a raceme of ten or twelve.

BLACKTHORN or SLOE, *Prunus spinosa*, makes many a stout hedge. It has a twisted twiggy growth, particularly well-adapted to the formation of an impenetrable fence when clipped; and when growing wild in a brake or covert it makes a dense thicket. It has a black bark against which its snow-white flowers in spring are very conspicuous; the leaves, slightly toothed and egg-shaped, come after the flowers. Later on come the beautiful blue fruits—sloes—which are eagerly gathered for making sloe gin in spite of the sharp thorns with which they are guarded. "Blackthorn winter" is the country name for the cold weather which often accompanies the blooming of the blackthorn in April.

BLACKBERRY. *Rubus fruticosus*. No hedge is complete without its bramble, rambling and strengthening the whole with its wiry thorned stems. Not only does the bramble bind the hedge plants together but by its habit of rooting from the stem it anchors the whole mass again and again to the ground. The leaves are hard and dark green, toothed at the edges, in three or five leaflets, one or two opposite pairs, and one terminal. The flower, of the typical five-petalled rose form, is white or pink, grows in a raceme, and may be seen from July onwards to September, the first ripe fruits being found in August. The bramble, as is to be expected with so ubiquitous a plant, has numbers of local names. It is called Garten Berry from the use of the stems to bind, or garter, eaves or faggots; and Lawyers, because "when once they gets a holt an ye, ye doesn't easy get shut of 'em." It is also the subject of numerous superstitions, and even to

this day country people refuse to gather blackberries after Michaelmas, when each year the devil goes to the trouble of stamping on them.

Barren Strawberry. *Potentilla sterilio.* It seems rather unnecessary that there should be a strawberry plant that cannot make strawberries, but this is nevertheless the case. In the flowering season it is easy to confuse the barren strawberry with the wild strawberry, the leaves and flowers being at first sight identical. A close comparison will reveal differences. The flowers of both plants are white and five-petalled, with yellow centres, but the petals of the barren strawberry are slightly notched at the top and are separate from one another, a strip of green calyx being visible between each two petals. The leaves also show a difference, inasmuch as the wild strawberry leaves—comprising three egg-shaped and deeply-notched leaflets similar to those of the garden strawberry—show deeply sunken nerve lines. The wild strawberry, moreover, sends out runners which root, forming new plants. The barren strawberry flowers early in the year and may often be found in bloom in March.

Dog Rose. *Rosa canina.* Here again we have a flower of the true rose type. It may, indeed, be the ancestor of many of the widely differing roses produced by cultivation, and it makes the best stock upon which to bud hybrid roses. In its wild state, rambling over bush or tree, or growing in isolation as a large bush, it is one of the loveliest sights of early summer. It climbs by the help of its strong curved spines, which also serve as a protection to the flowers. The branches are long and arching, resembling the blackberry in this, but they do not root. The leaves have four opposite pairs of leaflets and one terminal, toothed and egg-shaped. The five petals are every shade of pale rose fading to white, and the five sepals fall back from the petals. The flowering

season is not very long and rarely exceeds a month; the blossoms giving place to ornamental scarlet fruits called hips. On the dog rose are frequently found little conglomerations of green spines not unlike a Spanish chestnut burr. These are the work of *Rhodites rosea*, a tiny wasp who chooses a rose stem in which to lay her eggs. The rose dislikes the feel of the foreign body in its stem and produces this fuzzy new growth as a result of the irritation it causes.

Crab Apple, *Pyrus malus*, is often found in hedges in fruit districts, where the trees may be seedlings from cultivated apples. There is no prettier tree than a crab apple in bloom, when the five-petalled rosy-white flowers cluster thickly on the branches, for five or six days in April and May. If left alone, the crab apple forms a tree twenty or more feet in height. The blossom is succeeded by small fruits, often brightly golden, at the end of August, which are as ornamental as the flowers, and can be utilized in making jelly. The leaves are ovate, occurring in spirals, dark green, and slightly toothed. The trunk is deeply ridged and the bark greyish and furrowed.

Hawthorn, *Cratægus oxycantha*, is the commonest of all hedging trees on account of its rapid growth and close thorny branches which soon make an interlacing fence. Fortunately it is also a pretty plant, even when kept closely clipped—as it must be to maintain a good hedge—for the brilliant green of the young leaves is one of the first signs of spring, and, being deeply cut and glossy, they are pleasing all through the summer, and turn a rich russet in the autumn. But when left to grow unrestricted the hawthorn makes a noble bush with widely spreading branches, laden in summer with masses of fragrant white flowers. This is yet another member of the great rose family, so we may count upon finding five petals and five sepals. The flowers grow in

thick clusters—a corymbose cyme is the botanical name for the inflorescence. The thorns are long and very sharp. The fruit is a little red berry, called a haw, very conspicuous in autumn and winter, until carried away by birds. A quick, or quickset, hedge is composed of clipped and layered hawthorn, and is called quick, i.e. alive, in contradistinction to fences of posts and rails. A country saying is: "If you want to spoil a quick hedge you don't want to do nothen to 'un, only leave 'un alone," meaning that to be kept growing a quickset hedge needs regular care. As soon as the branches start growing freely upwards they cease to make growth at the base, and the fence becomes ragged and full of holes.

Bryony, *Bryonia dioica*, is a somewhat sinister-looking climbing plant which clings to the stouter hedge plants by means of strong coiled tendrils like springs. It is one of the most rapidly growing of perennial plants, and is diœcious. The leaves are large and rough, heart-shaped with five deeply-cut lobes. The flowers are inconspicuous, being of a pale yellowish-green. The male flower is about half an inch across and the female rather smaller. The fruit is glossy and scarlet (and poisonous), and looks rather repulsive.

Hemlock. *Conium maculatum.* So many umbelliferous plants having great similarity of flower and habit grow by the wayside that it needs considerable practice to remember which is which. It is important to be able to distinguish the hemlock, because it is poisonous, and possibly with this end in view Nature has provided a danger signal by printing purple dots on the stem, which has also a coating of bluish powder. The plant has a nasty smell which is generally sufficient to keep animals from eating it. The stem is tall and much branched, the leaves being deeply cut and fern-like. The flower head is composed of numerous tiny white

flowers, set in large terminal umbels. They appear in June and July.

Cow Parsnip, or Hogweed, *Heracleum sphondylium*, has a coarser growth than the hemlock, its umbels being wider and flatter, and its stalks much jointed. Its blooming season is in May and June. It is found in ditches and hedge-banks all over the country, and is, indeed, widely distributed in Europe, Asia and Northern Africa.

Hedge Parsley, *Caucalis anthriscus*, or upright hedge parsley—to distinguish it from knotted hedge parsley, which is a creeping plant. The flowers are purplish-red on opening, but become white. The stem is solid, whereas both hemlock and cow parsley have hollow stems. It blooms in July and August.

Dogwood or Cornel. *Cornus sanguinea*. This handsome shrub often occurs in hedges, where it is conspicuous in winter by reason of its red stems. It is of bushy habit, the branches erect, the leaves egg-shaped and deeply veined. The flowers, which are small and cream-coloured, set in cymes, open in June and July, forming later black fruits. The wood of cornel is very hard and can be turned to make skewers.

Moschatel. *Adoxa moschatellina*. We must look near the ground to find this humble little plant, which hides its six inches of stalk beneath the luxuriant vegetation of July and August. It likes shade and a clay soil, and protection from wind. The leaves are three-lobed, and the flowers are borne in fives at the head of a single stalk. They are greenish in colour, the topmost having four petals and the side ones five petals each. It has a musky smell, as the name implies. The first name, Adoxa, signifies " of no esteem ", on account of its retiring habit.

Elder, *Sambucus nigra*, is one of the commonest of trees

in most parts of Great Britain, where its large plate-like cymes of creamy-white flowers are a familiar sight in June. It sometimes attains a height of thirty feet, but is more commonly about fifteen feet high. The bark is rough and light coloured. The leaflets are arranged in three or four pairs, opposite, with one terminal leaflet. The fruits are purple-black, very juicy and sweet, and much used for home-made wines. Birds are very fond of the berries and aid in the wide dispersal of the seeds. It is the subject of many superstitions, and various parts of the tree were formerly used in medicine.

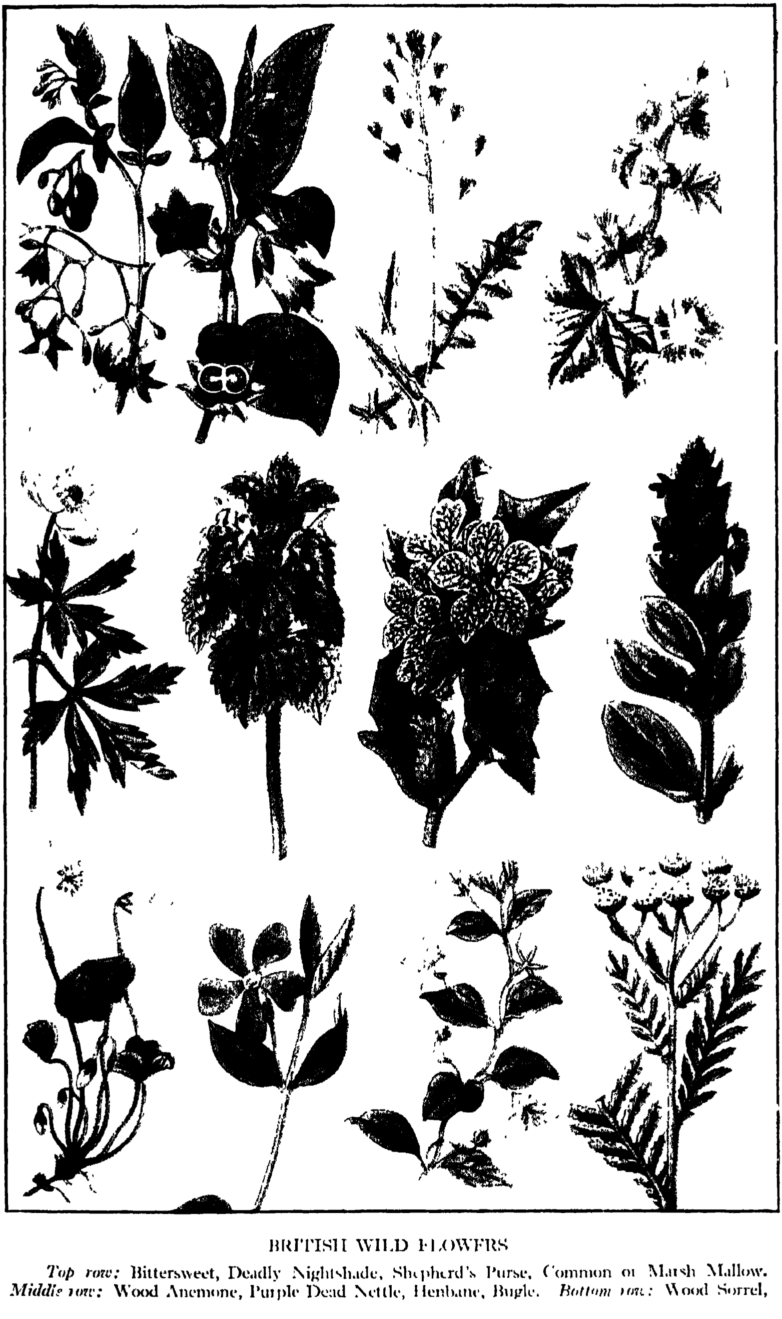
CLEAVERS, *Galium aparine*, can be found on most hedge banks, ramping and trailing, sending its branches wherever they can find a stem to cling to. For, as every child knows, cleavers will stick to anything. The stem is rough and angular, and the leaf edges are rough also. Cleavers hangs and climbs by means of these turned-back hooks. Tiny white flowers appear in the axils of the whorls of leaves and are replaced by round prickly fruits which rely upon their cleaving qualities for dispersal.

TEASEL. *Dipsacus sylvestris*. This handsome plant is not approved by farmers, and has to make the best of a location by the roadside instead of inside the hedge, where it used to be cultivated; the prickly heads being a means of carding wool. It often reaches a height of four to five feet, a single erect stalk having large lance-shaped leaves, stalkless and almost clasping the main stem. In the little hollows thus formed in the axils water collects, in which small insects, climbing up the stalk to drink honey from the flowers, are drowned. The flower heads are large, an elongated cone shape, composed of numerous lavender florets accompanied by long green bracts, while the calyx produces curved bracts almost to the height of the flower head.

Hoary Ragwort. *Senecio crucifolius.* In late summer it is not uncommon to see lanes bordered as if by a carefully planted row of ragwort—a tall strongly-growing plant crowned with bright gold flowers. Or sometimes, to the grief and shame of the farmer, one may see whole meadows rendered golden by masses of this plant. The leaves are very deeply cut, almost to the central vein, and are greyish in colour, thus accounting for the descriptive name which means " hoary ". The flowers, of the usual daisy shape, are carried in corymbs of six or eight.

Nipplewort, *Lapsana communis*, is a tall plant, with large egg-shaped leaves, frequently found on waste places or on dry and dusty banks. It has no particular beauty to recommend it, but has one noticeable feature in the contrast between its heavy leathery leaves and the fine wire-like stalks, springing a foot or more above them, which carry the flowers. The latter are inconspicuous, the yellow florets hardly protruding beyond the whorls of green bracts. They open widely only between six and seven, and ten and eleven —" weather permitting ". They remain tightly shut while rain falls or threatens.

Great Bindweed. *Calystegia sepium.* This is the handsomest specimen of the convolvulus family growing wild in Britain, and in most parts of the country it climbs over the summer hedges with delightful effect. It has a white creeping root which is perennial and sends numerous shoots upwards. The stems are twisted, twining and binding with great firmness in a direction against the sun—that is, " anti-clockwise ". Two hours is stated as being the time required by the growing shoot to make a complete revolution. The leaves are large and arrow-shaped. The flowers last only a day, but have the rather rare habit of opening in strong moonlight. They are shaped like bells, and are pure white,



BRITISH WILD FLOWERS

Top row: Bittersweet, Deadly Nightshade, Shepherd's Purse, Common or Marsh Mallow. *Middle row:* Wood Anemone, Purple Dead Nettle, Henbane, Bugle. *Bottom row:* Wood Sorrel,

without markings and scentless, and are therefore not visited by many insects.

RED BARTSIA. *Bartsia odontites.* Like many other plants which affect a sandy situation, Bartsia is semi-parasitic and lives upon the roots of grasses. It is an untidy plant of shrubby habit, about one foot in height. The stem is much branched and the long lance-shaped leaves turn backwards, as do the bracts surrounding the blossoms. The flowers hang downwards in a raceme, reddish purple, and are lipped in form.

WOOD BASIL, *Clinopodium vulgare*, in spite of its name, does not confine itself to woodlands. It is most often found on rocky soils. The stem has numerous branches, and stems and leaves are all slightly downy. The leaves are a pointed heart shape, toothed at the edges, and carried on short stalks. The flowers appear in leaf axils at the top of the stem, in whorls, and are pink and tubular, the involucre being of soft close bristles. The blooming season is a long one, from June to August.

GROUND IVY. *Nepeta hederacea.* There is no real resemblance between this trailing plant of the hedgerows and the true ivy, except in the creeping, twining habit. The ground ivy has a square stalk, with numerous opposite kidney-shaped leaves deeply scalloped at the edges. The pretty little flowers are bluish violet, tubular, growing in whorls at the leaf axils. The leaves have a bitter taste, and have been used in some parts of the country to flavour ale.

BUGLE, *Ajuga reptans*, has many points of similarity with self-heal, in association with which it is often found. Bugle is by no means addicted to any one class of habitat. It often grows in meadows or in woods, while it does not despise a damp hedge-bank. Dry ground does not suit it. It has an erect habit, but increases itself by underground

stems. The leaves at the base are on long stalks, but those on the stem have no stalks. They are glossy and dark green on the upper sides, the undersides frequently showing red. The tubular flowers are purplish blue, borne in a dense spike and surrounded by calyx and bracts of a blue tinge. It may reach a height of twelve inches, but is more often shorter. It is in bloom in late spring and early summer.

NETTLE. *Urtica dioica.* Wherever man has disturbed the ground there surely will the nettle spring. It is rampant in neglected gardens and loves to spread over rubbish heaps, covering the unsightly litter with its scarcely less unsightly herbage. The whole plant is covered with stinging hairs, pointing forwards, each hair having a spot of siliceous (i.e. glass-like) tissue very easily broken, and through the aperture thus made an acid fluid is ejected, causing the sting. The leaves are pointed heart-shaped, deeply notched and growing at varying angles up the stem. The flowers appear in loose spikes of tiny green blossoms at the axils. Most gardeners know the one good point about the nettle, which is a yellow fibrous root, easily pulled up.

BLACK BRYONY, *Tamus communis*, differs from white bryony (p. 219) in that its leaves are undivided, resembling those of the bindweed in shape though not in colour. It has a large black rootstock, and twining stems. The flowers are greenish yellow in racemes, very small, and bell-shaped, forming red berries later.

LORDS AND LADIES, *Arum maculatum* (cuckoo pint), is botanically interesting as well as a harbinger of spring, and amusing to find when it first sends up its green sheaths amongst the low growth of the hedge-bank. The root is a tuber which is said to be edible when ground, and from it the leaves spring direct. The leaves are broad and glossy, shaped like arrow-heads, and have net-veins, unlike most

monocotyledons. After the leaves are well grown, a pale green spathe makes its appearance and within the spathe will be found a pinkish-purple spike (spadix). At the base of the spadix, where the spathe swells, will be seen two rings of bracts, between which is a cluster of stamens, and below the lower ring of bracts a cluster of pistils. The coloured spadix attracts flies which creep down inside the tube, past the bracts, brushing against the stamens as they go, and carrying down some of the pollen to the pistils. Then they find that, although they could push the bracts downwards from above, they cannot push them upwards from below, and must remain prisoners. The earliest visitors in all probability die in their green prison and are consumed by the plant, but later-comers are more fortunate, for as soon as fertilization has taken place the bracts wither and the insects are free to escape. They then go on to another plant and scatter the pollen collected from their first enslaver, thus effecting cross-pollination, by which means only can the ovaries be fertilized. In due course the spadix and spathe wither and disappear, and all that remains is a thick spike of tightly-packed red berries—which are poisonous.

PERIWINKLE, *Vinca minor*, is probably an "escape" more often than a true wilding, but where it is established it spreads far from its original home. It has a trailing habit, the trails sometimes attaining a length of several feet; the leaves are opposite, pointed and oval, very dark green and glossy. The flowers may occur at any time between March and September and are a beautiful deep blue, with a white eye. The corolla begins as a tube, but opens out into five deeply-cut petals.

HONEYSUCKLE. *Lonicera periclymenum.* No list of hedgerow plants would be complete without this, the sweetest of all

wild climbers. The first green to be seen in the hedges, often appearing at Christmas or soon after, comes from the twin leaves of honeysuckle proudly borne by the stiff wiry stem. From May onwards throughout summer the creamy-white flowers may be seen. The flowers are in clusters at the end of long flower stalks, the petals turned back, and the stamens protruding, yellowish-cream on the upper sides and reddish at the back. The fragrance is delightful and perfumes the air. As the flowers grow older the colour deepens and the petals roll up. Ultimately, red berries only remain.

Ivy, *Hedera helix*, may be found wherever there is a shrub or tree to support it, and whatever its detractors may have to say of its greediness and evil effect on other plants, most people will agree that in leaf and habit it is a pretty plant—in moderation. Many a deciduous hedge is made attractive in winter by the glossy ivy leaves clinging to its trunks. Some of the smaller ivies show variations in colour which are pleasing. I am tempted to say " This plant has the ivy habit " and " The leaves are ivy-shaped ", but fear this is hardly an explicit description, although the ivy is so well known that it might fairly be used as a type. The stems have apparently no power to lift themselves upwards but cling tightly by means of tiny disk-like suckers. The lower leaves are three-lobed, the upper five-lobed, all with strongly-marked veins. The flowers are borne in clusters on long stalks, which are strong and erect. The flowers are greenish-yellow, having five triangular petals, five sepals and five stamens. They are in bloom quite late in the year, often in mid-winter, and the fruits, rounded berries with little flat crowns (the remains of the calyx) either yellow or black, may be found in spring and early summer. The pretty little ivies which trail on banks and the bases of

hawthorn or other small trees do not flower, and are called barren ivy.

TANSY, *Tanacetum vulgare* is a true native of Britain, but was cultivated so widely in olden days that its presence on roadsides or river banks may often be by "escape". It is a tall, handsome plant, with dark green feathery foliage. The erect flower stalks are crowned by corymbs of small flowers like gold buttons. The whole plant has a very strong distinctive smell, and a similar flavour. It was used in medicine—tansy tea being a common specific for colds—and in cookery as a flavouring for cakes and puddings.

CHAPTER XXI

Flowers of the Cornfield

As I have said before, the best definition of a weed is that it is a flower in the wrong place. Now in cornfields, or any cultivated lands, all wild flowers must be considered as weeds. For the purposes of these chapters, however, it cannot be denied that some flowers will get into the wrong places, inasmuch as a flower that according to the books should belong to the meadows may at any minute spring up in a cornfield, while one that in theory belongs strictly to a cornfield may be found sunning itself in a waste place. Of course, the final determination of plant distribution is moisture. You will rarely find a marsh plant growing on a sandy bank, or a flower of the chalky uplands cooling its toes in a stream. But, other factors being equal, plants are ready to do their best in any situation that is not too dry or too wet for them. These sub-divisions of our flora, therefore, cannot be taken as hard-and-fast rules obeyed rigidly by every plant, as few plants are so particular that they demand the best conditions every time.

CORN BUTTERCUP. *Ranunculus arvensis.* This member of the buttercup family has little chance of being confused with its relations, for, as the word *arvensis* implies, it grows on arable land. It is a tall erect plant, the stem much branched with groups of small leaves at the stem divisions and midway between nodes and terminals. The bright gold flowers

appear at the tops of the stalks, small in comparison with the height of the plant. As this plant grows in amongst the corn it is cut and bound up with it, to the great detriment of the crop, and unfortunately, it has no fungoid or insect enemies to check its propagation.

COMMON RED POPPY. *Papaver Rhœas.* Can there be anyone who is not familiar with the red poppy? This is certainly one of the plants which flourishes equally well by the wayside or in the rich soil of the cornfield, and I have seen it growing on a refuse dump in a bleak city. The bright scarlet flowers, each of the petals having a black spot at the base, are borne on erect hairy stems. The buds, wrapped in a strong hairy calyx, hang down, but turn upwards on opening. The leaves are much cut and divided. Masses of this plant may be seen amongst growing corn, and in railway cuttings, forming a delight to the eye throughout the earlier summer months.

FUMITORY. *Fumaria officinalis.* A common name for this plant is earth-smoke (*fumus terræ*), and indeed, there is something vapourish about the frail red-purple blossoms. Old botanists called it fumitory from a belief that it rose in vapours from the earth without seed. The leaves are a soft grey-green, very much cut and fern-like; the stem is semi-trailing with swellings at the joints which give strength. The loose spike of small tubular flowers appears at the top of the stem, and the blossoming period extends from May to September. Although so unalike, the fumitories are near relations of the poppies, and that accounts, perhaps, for their close proximity in the cornfield.

CHARLOCK. *Brassica arvensis.* Like a very coarse mustard, the bright-yellow flowers of the charlock obtrude themselves amongst the green stalks of the growing corn. Like all members of the Brassica family it has a spike of cruciform

flowers forming long narrow seed-pods. The leaves are narrow and roughly toothed. The plant generally divides into two about half-way up the stem, and has a compact shrubby habit. The black seeds have an acrid burning flavour, and are sometimes ground to adulterate mustard. The charlock is a troublesome weed which spreads rapidly and causes much annoyance to farmers.

WHITE CAMPION, *Lychnis alba*, is a very attractive plant. It is said to follow cultivation, and thrives in cornfields, but it seems equally at home in grasslands. The stem is tall and erect with branching stalks, the leaves egg-shaped. The flowers grow in threes or fours at the terminals, consisting of five white petals borne in a long tubular calyx. It is a flower of early summer and is seen at its best in the evening, as the blossoms droop about nine o'clock in the morning, except in dull weather.

CORN COCKLE. *Lychnis githago.* In June and July these purple flowers may be found in cornfields, but rarely anywhere else, except in such places as poultry-runs, where the seeds have been scattered with the corn. The plant is tall, having stiff, much divided stems, very hairy and swollen at the joints. The leaves are narrow and hairy and the calyx very long, the sepals standing out beyond the petals. The plant may reach three feet in height. The seed-pods are large, somewhat resembling acorns in shape and size.

SPURREY. *Spergula arvensis.* There are several varieties of spurrey, this one being known as the corn spurrey. It is a tangled untidy-looking plant. The stem is much branched and has swollen joints, while the long needle-like leaves grow in whorls. At the top of the stalk is a much-divided stalked cyme of small white flowers, insignificant and scentless. The seeds scatter widely from an explosive seed-pod, and have given the plant the name of spergula, from Latin,

spargo, I scatter. It can be used as fodder, or even to make bread in times of scarcity. Corn spurrey greatly resembles common spurrey (*Spergularia sativa*), except that its leaves are longer; and sand spurrey (*Spergularia rubra*) may be distinguished by its pink or purple flowers. There are four varieties of Spergularia known as sea spurrey, which grow on the seashore and resemble each other closely.

SHEPHERD'S NEEDLE, or VENUS'S COMB. *Scandens pecten veneris.* This plant earns its name from the habit of the seed-pods, which are produced in an orderly line, very like the teeth of a comb. The stem, which at the base is purple in tint, is rarely more than twelve inches high, and bears an umbel of small white flowers. The leaves are light green and very sharply cut, very like carrot leaves. It is a very common weed in cornfields, and not a vicious one, as it contains a good deal of nutriment, and is not to be despised as fodder.

FOOL'S PARSLEY. *Æthușia cynapium.* This is one of the tiresome plants which, though classified under weeds of cornfields, ought also to be classified under every other heading except marsh and seashore. It is, in fact, one of those accommodating creatures that will thrive almost anywhere, and though primarily a sand plant, will grow equally well on clay. It is, however, a useless plant—indeed, it is highly poisonous, and though it looks pretty growing in the shade of the hedge or in the company of tall buttercups, its sickly odour prevents its being a favourite amongst wild flowers. Fool's parsley is a tall plant, dark green, with beautiful fern-like leaves. Large umbels of white flowers are borne on the smooth, shiny stems, and the distinctive mark of this plant amongst the many umbelliferæ which closely resemble it is the group of three long bracts which hang below the umbel. It is avoided by insects. It is said

to have a hot acrid taste and to cause violent sickness if eaten. It is in bloom from July onwards through the later summer.

Field Madder, *Sherardia arvensis*, is a humble plant which calls attention to itself by mass formation. It is a rough plant, the stem being rough and square, and the stalkless leaves, which grow in whorls of fours, fives or sixes, are rough to the touch. The flowers form a small pink or lilac umbel, and, though singly inconspicuous, provide quite a bright colour in a company of plants. The name Sherardia is derived from that of a seventeenth-century botanist, Dr. Sherard, who lived in Leicestershire. The flowering season is from April to September. It very much resembles woodruff in habit.

Lamb's Lettuce. *Valerianella olitoria.* If ever you find a forget-me-not which carries tiny flowers in cymes, you have found lamb's lettuce. The single flowers are like miniature forget-me-nots, but are differently arranged. The stem repeatedly divides into two branches; the radical leaves are rounded, the upper ones few and lance-shaped. This plant is used as salad, but has little flavour. It is sometimes grown in gardens under the name of corn salad.

Corn Marigold, *Chrysanthemum segetum*, is one of the most conspicuous of weeds. In June or July one may sometimes see fields golden with its blossoms, of the ordinary composite type, deep yellow, about two inches in diameter. It grows to a height of two feet, the stem and leaves being greyish-green. The upper leaves are numerous, and clasp the stem in a distinctive way. It is a coarse plant, individually; its claim to beauty lying in the strong gold of the massed flowers. It is regarded by farmers as a noxious weed.

Cornflower. *Centaurea cyanus.* The alternative name of

bluebottle is an insult to this charming flower, which has no resemblance at all to so foul a thing as a bluebottle. It has a branching stem with long, narrow stalkless leaves, both stem and leaves being downy. The flowers are normally deep, dark blue, one of the truest blues in the floral world, but occasionally white or purplish varieties are found. The blue portions of the flower—the ray florets—radiate outwards and attract insects to visit the organs within their circle.

CORN SOW-THISTLE. *Sonchus arvensis.* This unpleasant plant is, like the nettle, a follower of man and his works. It grows equally well on land that man has cultivated, and land that man has laid waste. It has an obstinate root, milky when cut, the radical leaves similar to those of the dandelion, the upper leaves being simpler in form and clasping the stem. It is a tall plant, lifting its rather repulsive flowers above the corn in June and July. The flower resembles the dandelion, but is smaller and paler, and the subsequent " clock " is less round. The flower is *heliotropic*, that is to say, it turns towards the sun and follows him in his daily journey across the heavens. When young the leaves may be eaten either raw or cooked as spinach, and rabbits are particularly fond of this plant.

SCARLET PIMPERNEL. *Anagallis arvensis.* This is another plant which follows man, but how great is the contrast between this and the sow thistle! The scarlet pimpernel is a pretty little plant of trailing habit, having five-petalled flowers of a glowing coral colour and small egg-shaped stalkless leaves. One is delighted to see it even in the garden, where it never becomes rampant, and is, indeed, one of the easiest weeds to uproot. It has long been regarded as a weather prophet from its custom of shutting up when the sky is overcast. It has been used as a " cure " for hydro-

phobia, and to avert the evil eye—no doubt both cures being ascribed to its pretty, friendly look. Yet it is not an edible plant, and birds are believed to be poisoned by it. It blooms all summer.

FIELD BUGLOSS. *Lycopsis arvensis.* Here is a blue flower—the colour of the spring sky after rain. It is notable amongst our wild flowers in that it has no other known name than bugloss. The flower is funnel-shaped, bright blue with white scales, enclosed in erect, deeply-cut sepals, and may be seen from May until the end of August. The foliage is very distinctive. The stem is angular and hairy, clasped by narrow blunt leaves which are covered with sharp hairs growing from tiny warts in the surface of the leaf. The name lycopsis was given to the plant from a fancied resemblance between the flowers and a wolf's face.

SMALL SNAPDRAGON. *Antirrhinum orontium.* This small shrubby plant is fairly common and prefers a chalky soil, but does not insist on it. The leaves are narrow and lance-shaped, and in the axils of the leaf-stalks the tiny purple and white flowers are found. These are of the labiate type, that is to say, "lipped", the lower lip being depressed by the visiting insect. The plant is inclined to be hairy throughout. The calyx is long and pointed, a distinguishing mark of this species.

IVY-LEAVED SPEEDWELL, *Veronica hederæfolia*, is not conspicuously blue like its relation germander speedwell. The four-petalled flowers are pale blue, small and solitary, appearing in the axils of the leaf stalks. It is a trailing plant, rarely more than three inches high, very soft and downy. The leaves, as the second Latin name tells us, are ivy-shaped. It is an early flower, blossoming among the young wheat and in all arable land and gardens, from March to June.

The GERMANDER SPEEDWELL, *V. chamædrys*, is a taller plant with larger flowers than the foregoing, and of a better blue.

The COMMON SPEEDWELL (*V. officinalis*) is a prostrate plant with small pale-blue flowers in erect racemes. The individual flowers are stalkless or nearly so. These both bloom rather later than the ivy-leaved speedwell.

HEMP NETTLE, *Galeopsis tetrahit*, is a tall handsome plant, very bristly and hairy, with sharply-pointed leaves, toothed at the edges, and whorls of flowers, purple, white or yellow, at frequent intervals up the stalk. The flowers are surrounded by long, needle-shaped calyx teeth. The flowers are lipped tubes, and are in season in July and August.

Germander speedwell

CHAPTER XXII

On the Chalk Downs

Try to make a mental picture of the south coast of England, as it appeared before Wight was an island.

A funny thing to suggest in the middle of a book about plants? Not really, as you will discover, if you have patience enough to read on a little. And in reference to this mental picture, I don't ask you to make a detailed or accurate one. I don't want you, for instance, to spend much time fitting in the river beds, which followed, in those times, courses very different from those we see now. But just think of the outlines of the coast of Kent, beginning, say, at Sheppey, and working round past the Forelands to the Sussex borders and Dungeness; past Beachy Head and the Seven Sisters, and then striking out to sea and giving Selsey Bill a wide berth —taking a line, in fact, from the point of the Bill outside the Isle of Wight, and straight across to the Isle of Purbeck by Swanage. If you are familiar with that coast you will guess the reason for this at once; but in case you are not, I will tell you what it is. So long as the sea meets the chalk cliff— the white walls of Old England that the poet sings about— it does not, in thousands of years, make much impression on them. But when it comes upon soft sand and gravel it eats it away in large mouthfuls. Therefore, where the chalk cliffs end just west of Brighton, the beach has receded considerably, even within historical times, and where it is not

protected by groynes and breakwaters it is receding still. The coast of Hampshire and the east coast of the Isle of Wight are of sand and gravel laid upon " blue slipper " clay—which is well named, as it is always slipping into the sea—and coast erosion is proceeding rapidly. On the western side of the island the chalk reappears, and with an interval of soft cliff in Christchurch Bay, it carries on into the Dorset coast.

These chalk cliffs round our shores are the termination of chalk ridges which have had much to do with the political history of England; but that is quite another story. The ridges run transversely from west to east in the south, forming the heights known as the North and South Downs, with branches running into Dorset and Buckinghamshire. Some of the most beautiful country in England rests in the folds of these Downs, which are nothing at all but the fossilized remains of sea creatures welded into rock by ages of pressure. All the Downs and chalk cliffs in the country have at some period lain under the sea. One result of this is the production of a type of landscape having very strongly-marked characteristics. The Downs are rounded hills, up to eight hundred feet in height, covered with short, sweet grass. Generally speaking, the sides are steep and the tops flattened, so that you may have a level walk of considerable distance along the top of a down. In Wiltshire and Dorsetshire particularly you may often see traces of the earth-works of prehistoric men on the sides or summit of a Down, either fortifications, or " barrows " for burial purposes. Here and there in the Down you will see a great white hollow or scar where the chalk has been taken for conversion into lime. And dotted about, or clustering in a grove, you will see the distinctive tree of the chalk country —the yew. Its dark foliage is never seen to better advantage

than when backed by the light-green Down and the white chalk scar.

Now you see where this little chat on the chalk is leading. The chalk country clothes itself with characteristic flora, so that if you were taken blindfold to a strange place and somebody brought you a bunch of cuttings from the nearest hedge which you could identify as yew, wayfaring tree, and wild clematis, you would be able to say—" I must be in a chalk country."

There are some plants that you will never find growing on the chalk—rhododendron is one of them, and heather is another—and there are others that are never happy away from it. It yields a cold, heavy soil for the ploughman to labour in, but once it is broken it rewards his toil with hearty crops. Stone fruit thrives on it, and in Buckinghamshire you will see cherry orchards where the trees are forty and fifty feet high. But really to know the plants of the chalk we must take our eyes from the skyline and grub about in the hedges and roadsides, where we shall find many unsuspected treasures.

DYER'S WEED. *Reseda luteola.* You might be excused for calling this plant wild mignonette, for it certainly resembles the well-known mignonette of our gardens. Botanists call two plants wild mignonette; one is *Reseda lutea*, and the other *Reseda alba*. *Reseda lutea* is a chalk plant, and *Reseda alba* is regarded as an " escape " from the mignonette of cultivation, *Reseda odorata*. *Reseda luteola* and *Reseda lutea* are very much alike, but they can be distinguished by the number of sepals. *Luteola* has four sepals, and a greater, but variable, number of petals, while *Lutea* has five sepals and six petals. The dyer's weed owes its wide distribution to its great use for dyeing wool and linen green or yellow. It is a tall plant with a graceful

spike of heliotropic flowers. The individual flowers are small, greenish yellow, the great number of stamens giving them a fluffy appearance. The leaves are shiny, long and lance-shaped. It has a long tap-root.

ROCK ROSE. *Helianthemum chamæcistus.* The rock rose is extensively grown as a plant for rock gardens, under the name of " sun rose " to distinguish it from Cistus, the true rock rose. These cultivated forms show a wonderful variety of colour, but in the wild state the rock rose is yellow. Though it is the true wild rose shape, having five petals (but only three sepals), it is not a member of the rose family but belongs to the Natural Order Cistaceæ. The plant is prostrate and trailing, rarely more than six inches high, the stems shrubby and rough to the touch. The leaves are narrow and oblong, borne on short stalks from nodes which also produce four sharply-pointed hairy stipules.

KIDNEY VETCH. *Anthyllis vulnaria.* Next time you hear anyone praising South Down mutton you may call attention to yourself by saying, " Ah yes. The excellence of the meat is due to the prevalence of *Anthyllis vulnaria* in the pasture." Kidney vetch is an extraordinarily pretty plant and worthy of love for its own sake, apart from the flavour it imparts to mutton. It has a silky appearance from which it has received its other name of beard flower. It grows from six to twelve inches high from a woody rootstock, having narrow opposite leaflets and a larger terminal leaflet. The yellow flowers, of the traditional lotus shape (a long tube formed by an upper lip, the standard; and a lower, small lip, the keel) are carried in a thick cluster at the top of the stem, and surrounded by a very silky calyx. It is one of the many plants owning " lady's fingers " as one of its names.

SAINFOIN. *Onobrychis viciæfolia.* If you are fortunate enough to be in a chalk country in early summer, you will

see whole fields covered with a softly crimson mist. A puff of wind—and the mist changes to silver; then back again to crimson. It is a field of sainfoin, a valuable fodder plant which has been cultivated in England since the early seventeenth century. Sainfoin is a tall plant, reaching a height of eighteen inches, with flexible stems ornamented with leaves of the usual vetch type, that is to say with many opposite leaflets and one terminal leaflet. The word *viciæfolia* means vetch-leaved. The rose-red flowerets are similar to those of the kidney vetch—the lotus shape—and grow in a close raceme, or spike. The unopened flowers at the base of the raceme have a silvery look which accounts for the changing tints as the flower stalks are bent by the wind. The origin of the name sainfoin is found in Saint Foin, as it was first spelt, in allusion to the legend that some stalks of it were amongst the fodder in the manger where our Lord was born, and miraculously blossomed to form a wreath for His head.

DROPWORT. *Spiræa filipendula.* At first sight this plant might be mistaken for meadow-sweet, especially when growing amongst grasses which hide its leaves. But the habitat would at once suggest the difference, for whereas meadowsweet is essentially a plant of rich lands, moist preferred, dropwort will grow on dry uplands provided some larger plant will give it a little shade. The leaves, however, are very much toothed and cut, almost fern-like, and the undersides of the petals are pink, thus giving a rosy flush to the corymb which contains some open and some closed flowerets. *Filipendula* refers to the fine thread-like rootlets from which the root tubers hang, and this word is popularized in the pretty local name of fillyfindillan.

SALAD BURNET. *Poterium sanguisorba.* We have already met with great burnet amongst meadow flowers (p. 206).

BRITISH WILD FLOWERS

Top row: Samphire, Thrift, Sundew, Fleabane. *Middle row:* Purple Loosestrife, Valerian, Sea Holly, Great Hairy Willow Herb. *Bottom row:* Arrow Head, Marsh Marigold, Water Mint.

This is its relation of the chalk lands. A tall plant with angular stems, the greenish-red flowers appear in July. The stamens are red, and the anthers yellow, while the flowerets, forming a rounded head, are green. The opposite leaflets are toothed, and rough to the touch. The plant is considered good for sheep, and the leaves when bruised taste like cucumber, and are used as an ingredient for cool tankards—in modern language " cups ".

WILD THYME. *Thymus serpyllum.* Although one of the smallest of our plants, rarely reaching four inches in height, and having tiny flowers and leaves, wild thyme makes its presence known to all comers by its pungent and delightful scent. On a sunny day throughout the summer this typically " herby " fragrance fills the air on the chalk downs, refreshing the weary climber who has been scrambling up the slopes slippery with burnt grass. It is an evergreen plant, prostrate and trailing, with tiny blunt leaves on short stalklets. The little purple, or purple and white, flowers are tubular and grow in whorls. The dwarf thymes are often planted in gardens between paving stones, because the scent is dispersed when the leaves are crushed.

BOX. *Buxus sempervirens.* Only occasionally do we see this noble plant growing naturally and attaining its possible height of fifteen to twenty feet. It is a slow-growing shrub, and needs centuries to show what it can really do. The trouble with box is that until recent times its timber was in such great request for all the purposes needing a hard, close-grained wood—for instance, mathematical instruments, combs, flutes, wheels, pins and pegs, nutcrackers, weavers' shuttles, dagger hafts—that not many large trees escaped destruction; and small trees were acclimatized in gardens and clipped and chopped out of recognition. A friend of Julius Cæsar's is said to have invented the art of clipping

trees into shapes—topiary work, as it is called—and the box lent itself readily to this purpose, as the close, smooth leaves permitted a good outline to be obtained. But when it has been left unmolested, box makes a dense, spreading bush, the thick branches covered with dark, bluntly oblong leaves; the very shiny surface being designed, no doubt, as is the case with holly and ivy, to allow snow to slip off and not to break the branches with its weight, and also for the purpose of " slowing up " transpiration in winter. Little green flowers appear in the axils in April. The principal use of boxwood nowadays is for croquet balls and bowls.

YEW. *Taxus baccata.* The " churchyard tree " grows freely on the chalk. It is less dense in habit than the box, the branches generally forking from the trunk at several feet from the ground. The leaves are smaller, almost needle-like and only slightly glossy. The branches, which in a large tree net so closely as to make a complete shade, are of a drooping habit, and the tree's tenacity of life, which enables it to survive even thousands of years, makes it a plant of solemn association. Tiny flowers of a brownish gold cluster in the leaf axils, jostling one another for light at the extremities of the branches. These form pink fleshy fruits containing a hard seed, which is very poisonous. The " fruit ", which is called an *aril*, is very interesting, being a development of a little plate on which the ovule is set. The yew is one of the naked seed plants, like the conifers and cycads. The yew in olden times was cherished on account of its wood, which made the best bows. Do you know the lines written by Conan Doyle—The Song of the Bow?

> The Bow was made in England;
> Of Yew wood. of true wood.

English archers were desperate fellows in an age when

archery was the principal method of warfare, and much of their skill and success must be attributed to the lavish supply of yew wood upon which they could draw for the manufacture of their bows.

Musk Orchid. *Herminium monorchis.* The chalk is especially rich in orchids. This specimen, flowering in June and July, is not conspicuous as it rarely exceeds six inches in height and is entirely green. The slender stem and solitary stem leaf are green, and the flowers are green, only the anthers showing a slight rosy tinge. It is very fragrant. The rather strange Greek name *Herminium* is derived from *Herm*, the knob of a bedpost, on account of the rounded shape of the tuber.

Travellers' Joy. *Clematis vitalba.* Over hedges and banks in the chalk country this beautiful plant spreads a mantle, green and white in summer and silver in winter. It is also known as old man's beard from the resemblance of its emptied seed-pods and withered tendrils to white hair. It climbs and rambles about, growing rapidly. The clusters of small star-like flowers are greenish white; the leaves, composed of several opposite leaflets, are greyish green. The stem is very tough and is sometimes used as a binding material or for making baskets.

Wayfaring Tree, *Viburnum lantana,* is another hedge plant of the chalk country which provides binding material. All through the summer this is an attractive plant. Its heart-shaped leaves are light green and downy, carried on mealy stalks. The flowers are white, quarter inch across, in large flat cymes at the head of the stem, and appear in May and June. Beautiful as they are, the red berries which succeed the flowers are even more beautiful. Altogether this may be considered one of the most ornamental of our flowering trees.

TRAVELLERS' JOY OR WILD CLEMATIS

Lady's Tresses. *Spiranthes autumnalis.* Here is another orchid; its characteristic feature being the spirally-twisted spike of flowers, greenish-white and fragrant. It is a smaller plant even than the musk orchid, and blooms late in the summer, in August and September.

Pyramidal Orchis. *Orchis pyramidalis.* This is a summer orchid, the dense spikes of pale rosy flowers appearing in July. It may reach a height of eighteen inches, and is a conspicuous plant on the short turf of the downs.

Valerian, *Valeriana officinalis*, is another plant that was once of great value to the herbalist, and the leaves were also used by the housewife in many kinds of broth and pottage. Present-day medicine uses it with caution as it is a very powerful drug. Valerian is a common sight on walls and railway cuttings, particularly in the chalk country, and may also be found by the waterside. It grows to a height of two to three feet, has numerous large glossy lance-shaped leaves, and large cymes of small red or white flowers. This plant is said to exercise a strong fascination for cats.

WATER CRESS, SHOWING FLOWERS AND FRUIT

CHAPTER XXIII

Flowers of the Waterside

In no class of habitat shall we find such a wealth of flowering plants as on the banks of ponds and streams. There is also, of course, a flora of the water itself, which cannot subsist on dry land. We can be sure, then, of many different species of flowering plants when our steps lead us to the moist valleys. There are the plants which like running water—the faster it runs the more oxygen it contains, plants that like the still surfaces of lakes to float upon, plants that like the stagnant water of undrained holes and ditches. All these kinds of water have plants in and around them.

WATER CRESS, *Radicula nasturtium aquaticum*, is probably the best known of all water plants, since it is in common use all over the country, and by careful cultivation can be made to continue in season for many weeks. In its wild state it quickly grows too large to be palatable. Its roots grow in the mud at the bottom of a shallow stream, and its stems and leaves lie along the water in the direction of the current. It may also be found growing in the wet mud beside a stream or pond. The leaves are egg-shaped, the larger leaves having several toothed leaflets, and the whole plant is a glossy light green. The four-petalled white flowers are arranged in a spike. Water-cress has a relation, the giant yellow water-cress (*Radicula amphibia*) somewhat larger than *R. nasturtium*, and having yellow flowers.

GREAT CHICKWEED, *Stellaria aquatica*, does not actually grow in water, but demands a moist situation. In favourable circumstances it reaches a height of three feet, and is the handsomest of all the stitchwort family. The hairy leaves are wide and long, sharply pointed, and the stem, which is also hairy, is obliged to reach upwards by the help of other plants. The white flowers have five narrow petals, divided almost to the base, between which the green sepals may be seen.

PURPLE LOOSESTRIFE, *Lythrum salicaria*, is one of the glories of summer. The foliage is dark green, the leaves being sharply pointed and toothed, the spikes of rosy-purple flowers growing in whorls being often a foot in length. The plant is so erect and compact in habit and so free-flowering that it is often planted in the water garden.

GREAT HAIRY WILLOW-HERB, *Epilobium hirsutum*, is a coarse-looking plant which endears itself to us by the brilliant colour of its sweet-scented flowers. The stem, often six feet tall, is grey-green and woolly. The leaves are lance-shaped, slightly toothed and stalkless. The flowers grow singly on long drooping stalks, and are richly rose-coloured, four-petalled. Its near relation, the rosebay willow-herb, *Epilobium angustifolium*, while not so tall a plant is even more conspicuous in flower, and is content to live within sound of running water without insisting on drinking it perpetually.

HEMP AGRIMONY, *Eupatorium cannabinum*, likes the waterside, but will also make itself at home in the hedge-row. It has a stiff stalk a yard in height, rough, deeply-toothed leaves and a mop of fluffy pinkish-white florets at the top of the stalk. One of its names is raspberries and cream, in allusion to the colouring.

THREE-LOBED BUTTERBUR. *Bidens tripartita*. This is not

a very conspicuous plant, but tall and well branched, making a freely spreading growth. The leaves are three distinct lobes deeply toothed. Flowers are single at the head of each stalk and are heads of yellowish-green disk florets, sometimes accompanied by ray florets and sometimes not.

COLTSFOOT. *Tussilago farfara.* This can hardly be described as an aquatic plant, since it is rarely found by the waterside. It does, however, like a great deal of water, and for this reason always chooses a steep slope where the rains of winter maintain a good flow of moisture; or a clay soil. It is frequently to be seen, for instance, clothing railway cuttings. It is a peculiar plant in that the rather disagreeable yellow flowers appear in early spring, often in February. They are composed of masses of disk and ray florets, mustard coloured. When the flowers are over, large heart-shaped leaves, very woolly, make their appearance, often covering large areas of ground.

YELLOW LOOSESTRIFE, *Lysimachia vulgaris,* likes woodland swamps and ditches. It is a tall, free-growing plant, having smooth opposite leaves, lance-shaped on a square stem. The arrangement of the flowers is that called a panicled cyme. The flowers are bright yellow, five-petalled, and are in season from July to September.

MONEYWORT, *Lysimachia nummularia,* is well known by the name of creeping Jenny. This plant grows best in damp and shady places where its glossy dark-green trails luxuriate at great length amongst the grass. It is entirely prostrate, with heart-shaped opposite leaves. The flowers resemble those of the foregoing, but are more glossy, and are carried singly on short stalks.

SCORPION GRASS. *Myosotis scorpioides.* A little plant closely resembling forget-me-not. Marsh forget-me-not is a common name for it. It has a tall branching stem, round

and hairy, with long, lance-shaped hairy leaves; the five-petalled blue flowers, having a bright yellow eye, are carried in a loose cyme—the type of cyme called by botanists " scorpioid ", meaning curved like a scorpion's tail.

WATER FIGWORT. *Scrophularia aquatica.* This is a tall, erect plant, square stemmed, often reaching four feet in height in a single unbranched stem. It is often found on banks away from water. The leaves are large, dark green and heart-shaped, opposite. Flower stalks spring from the leaf axils, carrying panicles of small red-brown flowers, slightly scented, in bloom all through the late spring and summer.

BROOKLIME, *Veronica Beccabunga*, an aquatic plant which likes to have its roots in the wet mud at the edge of a stream or pool. It has a smooth fleshy stem, of a reddish tinge, with thick, oval leaves notched at the edges. It has spikes of bright blue flowers with white centres which open only in sunshine. It is a poisonous plant.

GIPSY WORT. *Lycopus europæus.* The English name was given to this plant because its juice is said to have been used by gipsies to stain their faces. It is a very rough hairy plant, with a square stem on which are long deeply-cut leaves, sharply pointed. Dense whorls of soft white flowers, with tiny red spots on the under lip, nestle at the leaf axils, sometimes as many as eighty flowers being found in one whorl.

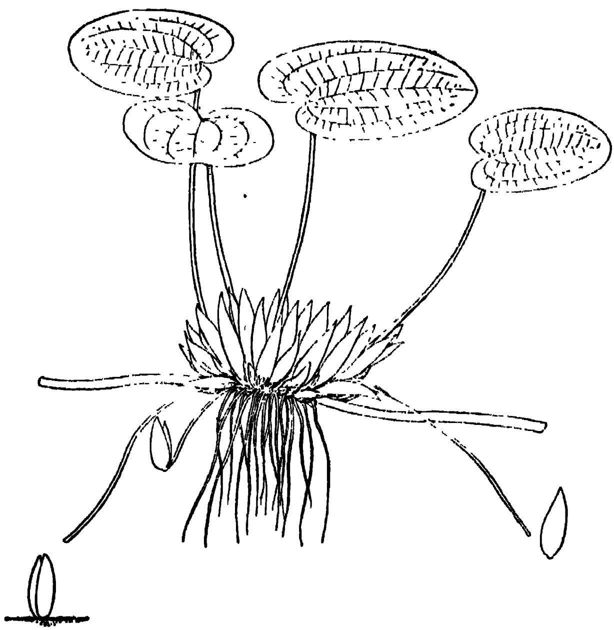
SKULL CAP, *Scutellaria galericulata*, may be found in many moist places. It is a pleasing plant, about two feet high, having a squared stem with opposite leaves, sharply pointed and deeply indented. The blue flowers grow in pairs and are tubular in shape, the inside of the corolla being white.

FROGBIT, *Hydrocharis morsus-ranæ*, lives a quiet life on stagnant water. Sometimes it floats freely, at other times

it sends down long rootlets which anchor it to the bottom. The leaves are fleshy, round or kidney-shaped, the flowers white, three-petalled, rising from a transparent sheath. Rather a rare plant.

SNAKE'S HEAD FRITILLARY. *Fritillaria meleagris.* This flower is rarely found growing wild in Britain, but it may be looked for in moist places in semi-shade, in April and May. It has a grass-like habit, rather grey-green. The flower opens to a large drooping bell, pale lilac in colour, patterned over with darker or lighter lines.

DUCKWEED, *Lemna minor*, floats on still water, making a pale-green mat, composed of myriads of tiny leaves, on



Frogbit

The winter buds in process of detachment from the ends of the submerged rhizomes. The buds lie at the bottom of the water through the winter, but rise to the surface as warmer weather comes on and there open out to form new plants.

the surface. Strictly speaking, they are not leaves but fronds, and the flowers, which are infrequent, occur at the margin of a frond, two little yellow-green male flowers and one female. It is eaten by water birds of nearly all kinds.

WATER PLANTAIN, *Alisma plantago-aquatica*, will thrive in any but swiftly-running water, or will continue to thrive if its water channel becomes silted up and converted into mud. The leaves are like large plantain leaves, all radical, rolled inwards at first, and unfolding as they grow taller. Tall flower stalks rise to a height of two feet, much branched, and bearing three-petalled lilac flowers at the tip of each branch.

ARROWHEAD, *Sagittaria sagittifolia*, can always be recognized by its broad leaves of the true shape of an arrowhead. It sends up a spike composed of large white flowers in whorls, three-petalled and purple centred.

FLOWERING RUSH, *Butomus umbellatus*, has the habit of many aquatic plants insomuch as the leaves are tall, sharp and sword-like. But it has an unusually conspicuous flower, a large umbel of rose-pink or lilac flowers borne on a tall straight stem. The flowers are large, on long stalklets, and have six petals.

CHAPTER XXIV

Flowers of the Heath

In this fertile smiling land of England there are many very large areas of land on which the vegetation is of a highly characteristic type. The determining factor, of course, is the nature of the soil. We have seen how the chalk gives birth to a particular flora. Now let us observe another type of flora, peculiar to the sandy lands. Here the soil is infertile, being generally a thin skin of sandy peat overlying coarse gravels. These gravels often form a hard, iron-bound mass called a " pan ", which it is impossible for roots to penetrate. The topmost layer of humus is sour, or acid. It is deficient in lime. Trees do not grow upon it, except for a few special varieties, and consequently there is no shade or shelter, and but little in the way of leaf mould. Only such plants can survive, therefore, as can withstand the bitter gales of winter and the fierce heat of summer. The vegetation of heaths exemplifies the adaptability of Nature, for while mainly very dry, many heaths contain patches and pockets of ill-drained land, and the same classes of plants have to meet both wet and dry conditions. A dry soil is warm, and a wet soil is cold, so that the blooming season may well be later on a wet soil than on a dry one. We may have a sandy heath of marine formation, or a moor left by the subsidence of lakes. Such moors are often peaty, or they may be acres of " mosses ", where generations of

sphagnum moss grow one above the other, making a thick spongy mass. All such lands strenuously resist cultivation.

MILKWORT. *Polygala vulgaris.* On the sandy heath, or amongst the stones of the gravel pit, this little plant will be found lifting its spike of dark-blue flowers during May and June. It is a trailing plant with wiry stems, with narrow lance-shaped leaves. It is rarely as much as six inches high. The flower is of tubular shape, generally blue, but variations in colour sometimes appear, and it may be white or even pink.

GRASSY STITCHWORT. *Stellaria graminea.* This is another plant of the sandy heath, but it also strays to roadsides and dry banks. It is similar to the well-known greater stitchwort (*Stellaria Holostea*) (p. 213) but much smaller in every detail. The white flowers, of four or five narrow petals divided in two nearly to the base, are borne in panicles. The stem is dark green and shining, carrying a few lance-shaped leaves, and the plant grows in a widely-spreading manner which enables it to climb about amongst furze and heather. The flowering season is long, from April to August.

FURZE. *Ulex europæus.* Also, more commonly, known as gorse.

> Kissing's in season
> When gorse is in bloom,

says the old tag, in allusion to the fact that, whatever the season of the year, it is always possible to find somewhere a spray of gorse bloom. The shrub, if unchecked, may grow to six feet in height, is very dense and much branched, the stems and branches being covered with leaves which have become modified into extremely prickly hairs and spines as a protection against grazing animals. The whole is darkly green and retains its colour throughout the year. But during the spring the entire surface of the bush is covered with the rich gold labiate flowers, giving off a most

delicious smell of honey and wax. The sight of some hundreds of acres of heath when gorse is in bloom is one never to be forgotten.

BROOM, *Cytisus scoparius*, comes into bloom as the gorse is fading, and continues the golden colour-scheme. The flowers are larger than those of the gorse, but less numerous, and not so strongly scented. Broom is not a prickly plant. The stem and branches are smooth, dark and evergreen, the leaves small and inconspicuous, lying along the branch rather than at wide angles to it. This is another plant of the sandy heath, but, although originally wild, it is now extensively cultivated for brakes and coverts and is found acclimatized in many unnatural situations. There are also great variations of colour, specimens of which find room very effectively in our gardens.

TORMENTIL. *Potentilla erecta*. The second Latin name of this flower refers to the habit of the stem and flowers, which droop at first, and later assume an upright position. It is a small plant, about six inches in height, springing from a red woody rootstock which is very distinctive. The five leaflets are arranged in a fan-shape, like five fingers. The yellow flowers have four petals, each having a dark mark at the centre, and eight sepals, and grow in cymes.

HEATH BEDSTRAW. *Galium saxatile*. This is one of the smoothest of the bedstraw family, the only one, in fact, that would make a tolerable bed, and for this reason it is named Our Lady's Bedstraw. It is a trailing plant which forms a thick mat and rarely climbs. Its stem is smooth, and the leaves, in whorls of four, five or six, are only slightly rough. The small white flowers grow in panicles and are sweet-scented; they may be found throughout the spring and summer. This plant requires more humus in the soil than do most heath dwellers.

CAT'S FOOT, *Antennaria dioica*, though a sand-loving plant, is frequently found in rock gardens, where it is included on account of its dwarf habit and bright colour. The leaves make a dense rosette from which spring flower stalks to a height of three inches. The brilliant pink flowers are carried in corymbs, and a peculiarity of this plant is that each individual bears either male or female flowers, that is to say, it is a diœcious plant. If you are fortunate enough to come upon a colony of cat's foot, you will find it interesting to see which plants are producing flowers having only female organs, and which flowers have male organs.

COMMON HAWKWEED. *Hieracium vulgatum.* There are numbers of varieties of hawkweed of different habitats. This one likes stones and rocky ground for its home, but prefers not to encounter the full rays of the sun. It grows to a height of two feet and is crowned with a panicle of yellow flowers, making a " clock " to disperse the seeds. The oblong leaves are bluish green, in a rosette, not very deeply notched, sometimes spotted.

SHEEP'S BIT SCABIOUS. *Jasione montana.* This plant likes crevices in rocks and quarries, where a handful of soil will give it root room. It may reach a height of fifteen inches, but is generally less, and the branching habit of its stems gives it a wide spread which detracts from the appearance of height. The leaves are narrow and lance-shaped, hairy, forming a rosette at the base and are infrequent on the stems. Like the other forms of scabious, the clustered blue florets have a very fluffy effect. Each little floret has its calyx and the whole flower-head is supported on a leafy involucre.

HAREBELL. *Campanula rotundifolia.* Of all our wild plants, none is more delicate than the harebell. " Lady's thimble " is a pretty name for it, the wide-mouthed bells, four or five

BRITISH WILD FLOWERS

Top row: Cross-leaved Heath, Crimson Heath, Ling, Eyebright. *Middle row:* Harebell, Milkwort, Rest Harrow. *Bottom row:* Tormentil, Fragrant Orchis, Spotted Orchid, Sheep's Bit Scabious.

on each hair-like stalk, being an admirable shape for a tapering finger. But although it is pre-eminently a flower of the heath and rocky moor, it may also be found on riversides and hedge-banks. Wherever it grows, its misty blue is a delight to the eye. So freely does it flower that the rest of the plant seems to have no significance—that is to say, few people could describe the leaf or recognize the plant before June, when the earliest flowers appear, though it is actually a flower of mid or late summer. Nevertheless, there are leaves, smooth and kidney-shaped, at the base of the tangle of slender stems which carry the flowers.

WHORTLEBERRY. *Vaccinium myrtillus.* On the granite of the Highlands and Exmoor and the sand of the New Forest the whortleberry is equally at home. It is an attractive plant, the leaevs bright green and glossy on the short shrubby stems which rarely exceed twelve inches in height. In spring the flowers may be found hiding amongst the leaves, each flower alone like a globe of pink wax. The flower disappears and a bluish-black berry takes its place, very sweet and luscious. Notwithstanding the discomfort of picking single berries from such a low-growing shrub, great quantities are picked on heaths and moors each year, to be made into pies and jellies. The fruit is very soft and must be used quickly. It forms a summer feast for grouse, and probably for other game birds as well.

LING. *Calluna vulgaris.* This is the plant which most southerners call heather. It covers many square miles of our country to-day, but is not apparently a plant of ancient origin, as its remains are not found in early geological deposits. It is a short branching shrub, evergreen, the leaves being tiny and stalkless, growing along the stem almost like hairs. The flowers are tubular and hang horizontally from the stem in a long spike, pinkish purple in colour, varying

in different localities. July and August are the flowering months, but the flowers wither on the stem and remains of them are to be seen all through the winter, giving a bleached appearance to the plant. The ling is a useful plant in rocky or sandy districts which resist cultivation. It can be eaten by sheep when other foods fail; it provides excellent honey for bees, it can be used for thatching and bedding, as a fuel and for mending roads, particularly over marshy patches. The Greek name Calluna (*calluno*, I cleanse) was given to the plant because brooms are made from it.

CROSS-LEAVED HEATH, *Erica tetralix*, frequently called bell heather, has a much larger flower than the foregoing, and demands more in the way of soil for its support. It is generally found in moister patches of moor and indicates the margin of a bog. The leaves, which are somewhat downy, grow in whorls of four, hence the " cross ", and the bell-shaped flowers, pale pink, cluster in a loose umbel at the head of the stem. It is a beautiful plant, and flowers nearly all the summer.

CRIMSON HEATH (Fine-leaved Heath), *Erica cinerea*, is the handsomest of all the heaths. It resembles ling and cross-leaved heath in its habit, but is notable for its freer growth, its fine dark-green leaves, and its whorls of crimson-purple flowers. The leaves are three in a whorl instead of four. Like the cross-leaved heath, it needs a soil containing humus. The ling is much the hardiest of the three and will grow in poorer circumstances and at higher altitudes than the others.

EYEBRIGHT. *Euphrasia nemorosa.* This is a cheerful little plant, blooming all summer on dry, gravelly situations, but being partially parasitic on grass roots it is only to be found where tufts of turf give it house room. It is a short plant with a stout stem ornamented with deeply-toothed leaves.

The spike of flowers appears at the top of the stem, white with a blue or purple upper lip and a yellow mark on the lower lip. On account of this colouring, which was regarded as similar to the colouring of a bloodshot eye, eyebright was used to make an eyewash, and the old poets show us how commonly the belief in its virtue was accepted.

> Then purged with euphrasy and rue
> His visual orb, for he had much to see.
>
> *Milton.*

> Yet Euphrasie may not be left unsung
> That gives dim eyes to wander leagues around.
>
> *Spenser.*

The real function of the coloured marking is, as usual, to guide visiting insects.

RED RATTLE. *Pedicullaris sylvatica.* As a companion to eyebright, we could hardly do better than to pick this little rose-coloured flower, no more than three inches tall, which we shall probably find growing beside it. Red rattle often covers large patches of heath on humus soil, from May onwards to the end of summer. The flower is large in proportion to the plant, which is of prostrate habit. The calyx is long and toothed at the tip, from which issues the lipped flower. The leaves are much divided and fern-like.

COW-WHEAT. *Melanpyrum pratense.* Although classed as a moorland plant, cow-wheat will grow in many varying situations, such as open woodland, meadow banks and damp grassland. It may be twelve to eighteen inches in height, but often looks less because its stem is weak and inclined to droop. The leaves are narrow, lance-shaped and opposite, of a dark green, having no leaf stalks, and the flowers are long, yellow and tubular, springing from a deeply-notched calyx. This again likes to feed on grass roots.

PENNYROYAL. *Mentha pulegium.* This member of the mint

family grows by the ditches or little pools which are found on heaths. Most of us have picked the leaves and chewed them for the sake of the peppermint flavour. Its growth resembles that of other mints, that is to say, the leaves, egg shaped or bluntly lanceolate, are in pairs close to the stem, with the pale lilac flowers in dense whorls at the axils. Pennyroyal, however, is more prostrate in habit than garden mint and is greyer in colour and often hairy, especially if growing in a hot situation. Its height is about nine inches, and it blooms in late summer and early autumn.

Creeping Willow, *Salix repens*, may be found wandering about, sending its short erect stems upwards from the creeping rootstock. It makes a dense bushy growth. The slender lance-shaped leaves are grey and silky and have no leaf-stalks. The flowers are male and female on different plants, appearing first as the familiar " palm ", the male flowers opening out in a tuft of golden anthers, very beautiful and conspicuous in April and May. The female flowers appear simply as green elongated bosses, made up of ovary and pistil and two stigmas.

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SEAWEEDS

1, Broad Ulva. 2, Cornucopia. 3, Caulerpa Cactoides. 4, Acetabularia Mediterranea. 5, Bladder-locks. 6, Long-stalked Laminaria. 7, Sugared Laminaria. 8, Bladder Wrack. 9, Serrated Wrack. 10, Gulf-weed. 11, Thalassiophyllum Clathrus. 12, Forked Dictyota. 13, Medicinal Coralline. 14, Corallina rubens. 15, Delesseria Lyallii. 16, Nitophyllum Crosieri. 17, Membrane-leaved Phyllophora. 18, Peacock's-tail Padina. 19, Banded Taonia. 13, 14, 15, 16 and 17 are red. 1, 2, 3, 4, 5 and 6 are green. The others are brown or greenish brown.

CHAPTER XXV

Flowers of the Woodlands

Plants which grow in woodlands are adapted to conditions of semi-shade and rich, cool, moist vegetable earth. Many such plants may be found in hedges and ditches which afford similar conditions. You would not expect to find many plants growing in really dense woods where the sun is almost entirely excluded, nor is there much variety in pine woods; but in mixed woodlands of deciduous trees there is a wealth of blossom to be identified. Many of these plants are dearest and most familiar to us, but a few are comparatively rare and strange. In order to catch as much light as possible, woodland plants commonly have broad, smooth, flat leaves.

WOOD ANEMONE. *Anemone nemorosa.* Another name for this beautiful plant is wind-flower, and it is indeed amazing that so fragile a thing can defy the winds of late March and April. The leaves are on long stalks and consist of three lobed and cut leaflets. The flowers appear at the top of separate stalks, mid-way on which are three bracts which protect the flower buds. The flower is actually composed of sepals and there are no true petals. The six sepals are delicate pinky-white, with a cluster of yellow stamens at the centre. When the flowering season is over the plant gradually disappears and all its substance is stored within the woody rootstock.

GOLDILOCKS. *Ranunculus auricomus.* This flower, often called the wood crowfoot, resembles a rather damaged buttercup, for although it may have seven petals it rarely has more than three. Both sepals and petals are bright gold. The flowers are in bloom all spring and summer, the plant being about a foot high, with long stalked leaves very deeply cut.

GREEN HELLEBORE. *Helleborus viridis.* This is a close relation of the Christmas Roses of our gardens, and is known as Easter Rose as it blooms in March and April. The root sends up a flowering stem early in the year, accompanied by lance-shaped leaflets, dark green and toothed at the edge. Much larger leaves appear when the flowers are developed. As in the wood anemone, the sepals compose the conspicuous part of the flower; they are rich green and about two inches across when fully opened. The true petals form a ring round the stamens.

COLUMBINE. *Aquilegia vulgaris.* Like all the members of the Natural Order *Ranunculaceæ*, the columbine has deeply-cut and lobed leaflets. There are few more beautiful things in Nature than a cluster of baby columbine leaves, each holding a crystal dewdrop in its centre. From amongst the leaves rise the flower-stalks, slender and branched, bearing clusters of drooping flower heads in May and June. Sepals and petals are the same colour, bluish-purple, or, more rarely, pale pink, each petal forming a horn curled at the tip.

VIOLET. *Viola.* There are several species of violet native to Britain, of which the commonest are wood violet and dog violet. All the violets have dark-green heart-shaped leaves and solitary flowers on long stalks, the flowers having five petals of unequal size and five sepals. The dog violet has pale lavender flowers with white centres, the wood

violet rather darker flowers. These flowers may produce seed, but the plant depends more confidently for reproduction upon inconspicuous green flowers called *cleistogamic* (hidden fruit) which appear later in the summer.

RED CAMPION, *Lychnis dioica*, is very similar to the white campion already noticed. The leaves, which are plain and smooth, grow in pairs up the stem, from which side-stalks carry the flowers. These have five red petals cleft almost to the base, held in a reddish bottle-shaped calyx. It is in flower all summer, and in sheltered places blossoms may often be found up to the end of the year.

WOOD SORREL. *Oxalis acetocella*, one of the most beautiful of our wild flowers, is fond of a clay soil. It is a tiny plant rarely more than three inches high, having leaves of three broad leaflets in the conventional shamrock shape which are sensitive to light and touch. The flowers are borne singly on slender stalks and are white bells veined with lilac. They bloom in April and May. Like the violet, this plant bears cleistogamic flowers later in the year.

ENCHANTER'S NIGHTSHADE. *Circæa Lutetiana.* This plant with the alluring name grows, very appropriately, in the darkly-shaded parts of woodland. It makes a mass of growth, for though the central stem rarely exceeds a foot in height it is much branched and the plant reproduces freely. The leaves are alternate, egg-shaped, purplish and downy. The flowers, which may be found from June to August, are tiny, growing in loose racemes, and are white with brilliant red stigmas.

WOOD SPURGE. *Euphorbia amygdaloides.* Most people are familiar with the spurges, whose stalks exude a thick white juice when broken. The wood spurge prefers a chalk or limestone soil. It has a simple stem from which the leaves, shaped like leaves of the almond tree (which is called *amyg-*

dalus), spring thickly. It is surmounted by an umbel of green flowers.

DOG'S MERCURY. *Mercurialis perennis.* In the districts where it abounds dog's mercury becomes a distressing weed in the garden, and it is not really ornamental in its wild haunts. It is a poisonous plant, eight to ten inches high, having a rootstock which creeps with astonishing rapidity, and an erect stem bearing many dark-green leaves of varied shapes and textures but mostly roughish and acute. The flowers are green and are borne in little tassels from the leaf axils.

GARLIC. *Allium ursinum.* A beautiful flower found in damp hollows. It springs from a bulb and its foliage has the usual characteristics of the monocotyledons. It bears a large umbel of starry white flowers, and would be much admired were it not for its strong smell.

BLUEBELL. *Endymion non-scripta* (generally referred to by its older name *Scilla nutans*). Another bulbous plant, preferring sandy humus but sometimes found in company with garlic. The leaves bend with their own weight and the flowers are carried in a prettily drooping panicle. The buds are erect, but the stalks droop when the flowers are developed in order to assist pollination, and spring erect again when the seeds are ready for dispersal so that they may be expelled farther from the parent plant. Some botanists decline to place bluebell with the Scillas, and have given it the name of Endymion. It is often—but wrongly—called wild hyacinth.

SANICLE. *Sanicle europæa.* An unusual looking plant in strong contrast to most of the flowers blooming in May. From an erect stalk spring leaves divided almost to the middle, three or five lobed, and of a dark green with a reddish tinge. The white flowers are carried at the top of

tall stalks in small panicles, and look much like small white knobs. They are succeeded by hooked fruits.

WOODRUFF. *Asperula odorata.* The distinguishing feature of this plant is the arrangement of the sharply-pointed leaves in whorls. They are very sensitive to light, and although normally dark green they soon take on a yellowish colour when growing in the shade. The flowers are a cluster of little white stars at the head of the stalk and appear in May and June. This plant has the sweet smell of new-mown hay.

PRIMROSE. *Primula vulgaris* needs little description, for its rosettes of spoon-shaped leaves, wrinkled and hairy, surmounted by solitary yellow flowers, must be familiar to everyone. It likes a clay soil mixed with humus, and grows to perfection on hedge banks. It is, alas, one of the plants which tempt hedge robbers, and it is in grave danger of becoming extinct.

WOOD LOOSESTRIFE. ·*Lysimacha nemorosa.* This not very common plant likes a clay soil. It has opposite leaves, egg-shaped and very glossy, from the axils of which grow the yellow flowers. These may be three inches across and are monopetalous, divided into five or six segments.

FOXGLOVE. *Digitalis purpurea.* This queen of the hedge-row will be found on well-drained stony ground, in light woodlands, particularly woodlands recently cleared. It is a downy plant, both the stem and the large egg-shaped leaves being greyish and covered with down. The well-known flowers grow all on one side of a tall spike and are tubular, pointing downwards, and are white, magenta, or splotched. The plant often attains a height of five feet and blooms from June to September.

CHAPTER XXVI

Flowers of the Seashore

What an unlikely place to look for flowers! What *could* grow in banks of shingle or stretches of sun-baked salt-encrusted sand, washed twice a day by the tides, beaten by the hungry waves and trodden by the feet of myriads of holidaymakers? The answer of course is nothing—that can be seen with the naked eye! But—leave the water's edge and the concrete promenade where the holidaymakers throng. Walk away from the town and the pier and the bandstand to that distant point where the concrete ends and the earth runs down to meet the sea. Here you will find plants galore: sand plants, shingle plants, chalk plants, granite plants, all braving the salt spray and the ocean breeze, and using their own especial weapons of defence. And whatever may be the type of coast with which you are most familiar, you must remember that Nature's variety is infinite. Not all seashores are bleak and windswept. Some are sheltered bays with deep gullies in the cliffs where tender plants flourish. Others—though not many on the coasts of the British Isles—are so rocky and barren that nothing more elaborate in structure than mosses and lichens can win a livelihood. Always there is *something* in the way of vegetation to be found, and a botanical expedition may well make an interesting change from the usual occupations of the beach. We shall be almost certain to find plants of inland origin,

for little pockets of soil become collected and watered by freshwater springs sometimes within a few feet of high-water mark. But we shall also find, if we are persevering, genuine maritime plants that not only *like* salt with their food but *demand* it, and pine and fade without it. Such plants, we shall notice, often have thick succulent leaves where they can store the moisture that the dry and barren conditions of their habitat would not otherwise provide in sufficient quantities. The foliage may, in its early days, be dark green, but the absorption of salt by the tissues prevents the manufacture of chlorophyll and consequently the green soon gives way to a yellow tinge. Other forms of maritime plants are glaucous—blue grey—like so much of the vegetation of dry areas. The greyness may be due to a coating of wax on the leaves, or to a covering of minute hairs; in either case it is a provision of Nature to retard transpiration; which, without some such provision, would be too rapid in the prevalent winds of the seashore.

SEA KALE, *Crambe maritima*, the highly-valued sea kale of our gardens, is a true seaside plant, and that is why the gardener treats the sea kale beds so liberally with salt. It may be found growing in large clumps on shingle or sand; a grey plant with thick stalks and large curling notched leaves. Thick corymbs of large white flowers appear in summer-time; the stamens and pistils pale green fading to purple.

SEA ROCKET. *Cakile maritima*. This is not a common plant but may sometimes be found in large patches on sand and shingle. It is glaucous, the stems much branched and rather fleshy in habit, the leaves deeply cut. The flowers are much like those of the garden rocket or the stock—four-petalled, growing in corymbs, white or mauve and sweet scented.

SEA CAMPION, *Silene maritima*, is a sand-loving plant,

rather sprawling in growth, with short erect stems bearing numerous rather large white flowers in late summer. The flowers are the same shape as the ordinary white campion, but larger, that is to say, the petals are notched and are held by a bladder-like calyx. The leaves are long and narrow.

SEA PURSLANE, *Arenaria peploides*, is an insignificant plant which forces itself upon the attention by its ubiquity. It is an edible plant, and may be pickled. Its roots are rhizomes which creep through the sand or shingle. The stem is fleshy and branched, the leaves stalkless and opposite, regularly placed, the pointed leaves and stem being glossy, smooth and dark green. Small white flowers are produced singly at the axils.

SEA HOLLY, *Eryngium maritima*, is another plant which has been adopted in our gardens, but for its beauty, not for its succulence. As its natural home is the sand, it adapts itself very well to garden life on light soils, where many herbaceous plants would not survive without expensive cultivation. It is conspicuous by its spiny leaves, like large holly leaves, and its metallic blue-grey appearance. It grows to a height of two feet with a stiff, much-branched stem clasped by the leaves. The thistle-like flowers are blue, encircled by stiff blue bracts, blooming in July and August.

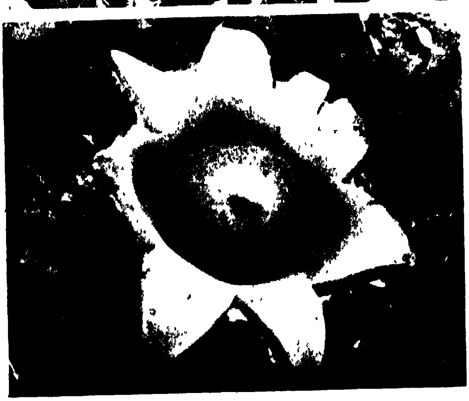
SEA LAVENDER, *Limonium vulgare*, covers many acres on the banks of estuaries and flat coasts. It used to be called *Statice*, the name now given to thrift. Limonium means belonging to a damp place. From a group of long bluntly-pointed radicle leaves a scape is sent up, bearing at the top a wide loose panicle of tiny blue flowers. These retain their colour for a long time and are gathered all through the summer for winter decoration.

SEA MILKWORT, *Glaux maritima*, is rather similar in habit to the sea purslane, as it creeps and has stalkless leaves.

Polystictus growing out of a decaying stump

Dog Lichen

Cord Moss with spore capsules



Above: Club Moss. *Below:* Earth Star

Cup Moss or Pixy Cups

FUNGI. MOSSES AND LICHEN

The leaves, however, are not arranged in regular rows up the stalk as are the leaves of the sea purslane, and the colour of the plant is bluish rather than glossy green. The flowers, which come in May and June, are quite different. They are *apetalous*, that is to say, the pretty little pink bell is really the calyx.

SEASIDE BINDWEED, *Calystegia soldanella*, likes a dry situation and plenty of salt with its food, therefore sandy cliffs suit it admirably. Its stem trails along the ground and rarely twines upward round a stalk. The leaves are long, heart-shaped and somewhat fleshy. The flowers are pink with yellow bands, borne singly and of the typical convolvulus shape, i.e. a long widely-opening tube.

SEA PLANTAIN, *Plantago maritima*, resembles the plantain found, alas, on so many lawns. It has a group of radical leaves; long, narrow, slightly fleshy, varying greatly in length; from which springs a scape bearing a thick spike of green flowers, very tiny and close to the scape head. It blooms in July, and the flowers open only in dry weather.

SEA BUCKTHORN. *Hippophaë rhamnoides*. This is a very handsome shrub much grown in seaside gardens for shelter and for its appearance, yet it is a true wild plant and not an escape. It is very twiggy and prickly in habit, with narrow lance-shaped leaves of a beautiful silver grey below and grey green above. The male and female flowers are borne on separate trees, in May, and are yellowish white, very small; the male in catkins in the axils and the females singly. The female flowers ripen into conspicuous orange berries, which are very pleasing in contrast with the grey foliage.

TAMARISK, *Tamarix gallica*, is another shrub which flourishes on the sea coast, and it has been so extensively planted for shelter and for binding sand that it is seen in

greater or less degree in nearly all seaside towns or villages. But it is not a wild plant and does not seed in this country. It often grows into tall, though straggly, bushes. The leaves enclose the branches and resemble the leaves of heather. The whole shrub has a feathery appearance. The tiny pink flowers grow in spikes and are in season all summer and early autumn.

YELLOW HORNED POPPY. *Glaucium flavum.* This is one of the most cherished of our wild flowers. The " horn "—an extension of the stalk—curves over the top of the large yellow four-petalled flower. The foliage is bluish green, the stem very smooth and clasped by the large wavy-edged leaves. Another feature of the plant is noticeable in the long curved seed-pods, often nine inches long.

COMMON SCURVY GRASS, *Cochlearis officinalis,* likes salt mud, and is found all round our coasts where clay or alluvial muds slip down to the seashore. It is a fleshy plant, the angular stem clasped by ivy-shaped leaves. The white flowers are produced in loose spikes and can generally be found all through summer. It can be eaten as salad.

WOAD, *Isatis tinctoria,* is a rare plant, so rare, in fact, that one is forced to wonder if this can really be the plant whose juice the Ancient Britons used for personal decoration. But where it *is* found it grows freely, making strong plants four feet in height. The leaves are long and narrow, with sharp points half clasping the stem. It forms large panicles of tiny yellow flowers clustered thickly together, later forming wedge-shaped seed-pods that bend downwards in ripening.

SAMPHIRE. *Crithmum maritimum.* This used to be a valuable plant, regarded as a great delicacy in salads or as a pickle. For this purpose it had to be gathered from its usual habitat, the cliff face, and the samphire gatherers

used to be let down on ropes to fill their baskets. The trade was never a popular one, and when one poor gatherer fell on to the beach at Dover it became generally out of favour. Samphire is a fleshy plant about twelve inches high, the stalk much branched and the leaves much cut into the semblance of fingers. The strongly-scented flowers grow in umbels and may be white or yellow.

THRIFT, *Statice maritima*, one of the prettiest of all wild flowers, is often found inland on chalky or limestone formations. It does not reach a height of more than seven or eight inches and has a group of narrow radical leaves from which rise several rounded scapes bearing single flower heads each composed of numerous rosy-mauve florets. It has a slight sweet scent.

CENTAURY, *Centaurium umbellatum*, again may be found inland on sand or gravel. From radical leaves the flower stalks grow to anything between six and twelve inches. The stalk divides frequently into two and ultimately carries a corymb of pink flowers, five-petalled, which do not open unless the weather is fine.

SALTWORT, *Salsola kali*, is an interesting plant inasmuch as in olden days it was used in glass-making on account of its high soda content. It is a fleshy plant, the leaves narrow and sharply pointed, covered with fine hairs and spiny. Tiny pink flowers occur in the axils.

CHAPTER XXVII

Algæ and Fungi

This book has dealt with only one of the five main divisions of the plant world. We have confined ourselves to the flowering plants, because, for nearly all of us, the highest forms of life are the most interesting. Here is the last chapter; and the few remaining pages shall show the ways of some of the humbler classes of plants. Perhaps we have been unfair in crowding them thus together at the end of the book, for the lower divisions of plant life are of very real interest and importance.

I have spoken before of the great division of the algæ, which includes the seaweeds, and you will remember that they are the simplest of the *green* plants. They all contain chlorophyll, though as we all know many of them are coloured red, or brown or yellow. On the coast every rocky pool is a paradise of these brightly-coloured plants—some with thick leather-like fronds and others of a fern-like delicacy. When the tide is low and the rock pools are visible, we accept without question the weak-looking threads and blades of seaweed attached to the rocks; but when the tide comes up and great waves lash the shore, we are surprised that such frail plants can maintain their hold—we can hardly believe that when the tide goes out again the delicate seaweeds will still be waving to and fro in the pools we visited the previous day. But there they are,

apparently quite unharmed by the rough waves of the storm.

True, if the storm has been particularly violent, a certain amount of seaweed will have been broken away and probably there will be a litter of seaweed above high-water mark. But if we examine it carefully we shall find, as often as not, that it is not the seaweed which has been broken, but the rock to which it was attached.

How is it that these apparently weak plants manage to withstand the rages of the sea? The answer is that they are extraordinarily flexible, and so well streamlined that the water has nothing to catch hold of and strip off or tear, and that the whole plant has an oily surface past which the water slips with the least possible friction. This quality also accounts for the slipperiness of seaweed—a quality that may be forced upon us in a very alarming way when we try to walk over rocks at low tide.

The seaweeds, however, represent but a small part of the algæ. Most of them are very tiny single-celled plants that are found floating in water. Often they are present in such vast quantities that they discolour the water—a fact lamented by disillusioned folk who make ornamental ponds in their gardens. Whoever has hoped for a clear pond in his garden will know only too well the trouble given by these microscopic plants. Sometimes the algæ manifest themselves in very strange ways. There is a phenomenon called " the breaking of the meres " which is produced by various kinds of these plants. It is observed in lakes, generally clear, which become suddenly entirely discoloured by innumerable quantities of algæ. The fish sulk and go to the bottom and the lake is muddy and unpleasant. Experiments were made with a drop of water from Newton Mere (Shropshire) when it was " breaking ", and it was found

that a pin's head dipped into the water carried away with it more than three hundred algæ.

"Gory dew" is a somewhat rare phenomenon due to algæ. Patches of blood-red slime occur suddenly on walls and paths, giving the appearance of fresh blood. When, from time to time, this red alga is found near Hastings, old superstitions connect it with the blood shed at the great battle of Hastings, and indeed it is apt all over the country to be taken for "the glorious memorial of ancient warfare" or even "the ground crying aloud for vengeance". And you may have heard of "star-slime", a curious deposit sometimes seen on grass, which is popularly supposed to be the remains of falling stars. This is also a form of alga that has its great growing season in the autumn when shooting stars are commonest. These algæ are all very hardy, and even snow can form a suitable home for them. It is not unusual for great patches of snow-covered mountains to be coloured a distinct pink by millions and millions of tiny red algæ. Others, going to the other extreme, have suited themselves to hot water and are to be found growing in natural hot springs. In Germany some have even been recorded as living in water at a temperature of 176° F.—water that is quite hot enough to give human skin a severe scalding.

From a botanical point of view one of the most interesting things about this group of plants is the way in which some single-celled algæ enter into partnership with certain fungi; and together form those curious leathery growths that appear on rocks, old walls and the bark of trees, and are generally known as lichens. An ordinary observer would never guess the unusual dual nature of these plants, for it is not until they are examined under the microscope that they are found to consist of a fungus and an alga. The

two plants, apparently, are not on entirely equal terms, for the alga can grow without the fungus, but the fungus is dependent on the alga. Neither plant, however, seems to lose by the partnership, and together life is possible where the alga alone would not succeed. The partnership is complex. It is probable that the filaments of the fungus dissolve mineral substances which are absorbed and elaborated by the cholorophyll-containing cells of the alga. Most of the nourishment of the plant is obtained from the atmosphere, and this is one of the reasons why lichens grow so exceedingly slowly.

For all their modesty and littleness, the lichens occupy a very important place in the vegetation of the world, for they are the first plants to colonize bare rocks. This colonization is obviously a very slow process, and to observe in a single lifetime a new rock surface entirely grown over with plant life is not possible, except, perhaps, in the most abnormal climates. First of all tiny patches of the smaller lichens appear. Gradually a thin crust, about a sixteenth of an inch thick, is formed over the face of the rock. The colours of these lichens are generally yellow or grey, but they may vary from pure white through all the shades of green and yellow to black. Where this crust is thickest larger lichens appear. Instead of lying entirely flat on the rock, they stand up and form a thicket of growth that is liable to catch and retain any stray dust or sand or odd pieces of vegetable matter that may become entangled in it. Perhaps a bird will perch on the rock and enrich the slowly-thickening crust with its droppings. Soon, among these larger lichens, mosses will appear, and then among the moss, some of the hardier grasses may find a roothold; then other small plants will establish themselves. These will grow over the mosses and in time the rock will be completely covered with vegetation.

From a directly useful standpoint, the reindeer moss (*Claydonia rangiferina*) is probably the most important lichen. In this country it grows among heather, and in the summer is scarcely noticeable. In the winter it greatly increases its size and its coarse grey branching stems are a common sight on the moors of England and Scotland. Though in Britain we make no use of it, farther north, notably in Northern Scandinavia and Lapland, it forms the winter diet of the reindeer, and without it these beasts would have difficulty in finding a living. With their powerful feet they scrape away the snow and manage to exist on what lichen they can find beneath. Several bales of this moss were obtained recently at great expense and difficulty as a treat for the reindeer in the London Zoo. The reindeer, however, greatly preferred the lucerne to which they had become accustomed, and they ignored altogether the moss that in their own country they would take such trouble to obtain. A similar lichen—the Iceland moss (*Cetraria islandica*)—is used in that country not only as a food for cattle but also for man. At one time it was considered an excellent food for invalids and great quantities were imported into this country, but of late it has gone out of repute.

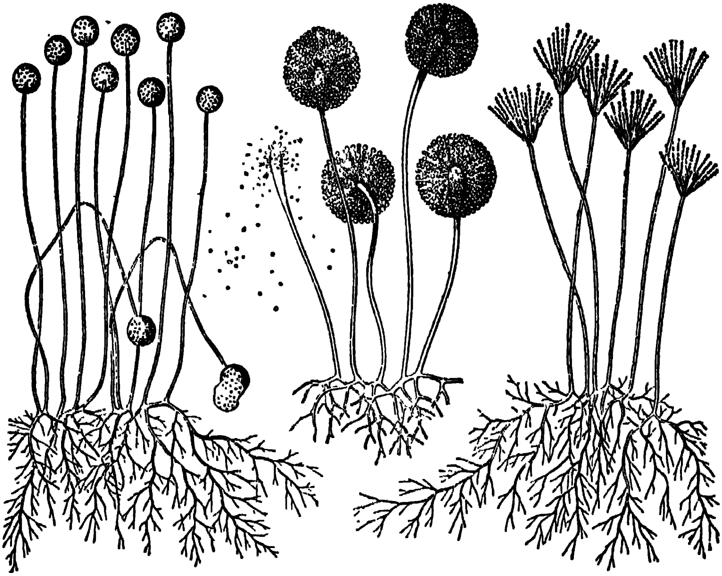
We have been speaking of the strange relationship of alga and fungus for the formation of the dual plants of lichen. I do not want you, however, to suppose that all fungi are dependent on algæ, or that all algæ are dependent on fungi. We will now look a little more closely at the great group of plants included within the important division of the fungi.

The most important fact about the fungi is that they do not contain chlorophyll. The part which is recognizably a mushroom or a toadstool is what is generally regarded as the fungus. In reality this is only the fruit of the plant.

Fungi

1, Milky fungus. 2, Fly agaric. 3, Common mushroom. 4, Ink-cap. 5, Stink-horn. 6, Puff-ball. 7, Parasol mushroom. 8, Jew's ear

Our mushroom is only a head containing the spores—microscopic single cells that are scattered abroad. When the spores fall on suitable ground they are able to grow and form the masses of mycelium that are the true fungoid plant. Who has not seen the strange white woolly threads which appear on dung or on any decaying vegetable growth? Those thin white threads are the " body " of the fungus. All their nourishment they obtain from decayed or even

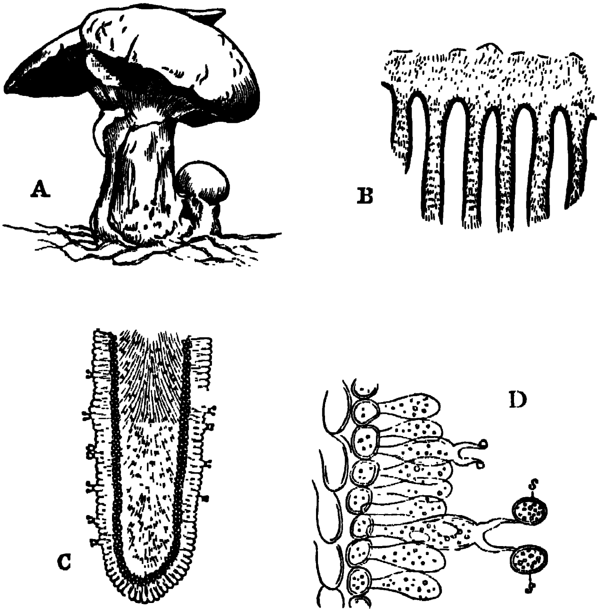


Moulds

1, White mould (enlarged 26 times). 2, Blue-green mould (enlarged 20 times). 3, Blue mould (enlarged 26 times)

living matter. Having no chlorophyll, they are incapable of creating for themselves the complex carbohydrates necessary for their existence. Consequently these they obtain from organic matter, and in the general scheme of Nature they reduce these complicated chemical substances to simple salts which in their turn can be assimilated by the higher plants.

Most of us are less interested in fungi as agents in the exchange of the products of decay than as presenting us with mushrooms and toadstools. We know that some may, and some may not, be eaten. In spite of general opinion, there are very few fungi that are really poisonous. There are certainly some that are virulent, as the brilliant red fly-agarics so common in autumn among the birches, but



The common edible mushroom

A, A group of mushrooms, two of which are full grown and one is still unopened. B, Section through the cap showing the gill-plates. C, Portion of a gill-plate more highly magnified. D, Part of C, still more highly magnified, showing spores *ss*.

most are harmless. Apart, however, from the mushroom, the truffle and the morel, they are for the most part tough and tasteless, and they are not eaten, not because they are poisonous but because they are unpleasant.

Not only do fungi feed on dead organic matter; a great number are parasitical and feed on both living plants and animals. Most familiar of these are the mildews, moulds and rusts that appear so plentifully on the leaves and stems of our most cherished plants. Roses are a common prey to these annoying pests, and every rose grower knows that unless his plants are constantly sprayed with fungicide, they will suffer badly from attacks of these microscopic fungi.

Some fungi are parasitical on animals. One kind attacks insects and grows on their bodies until death occurs, by which time the fungus has produced its spore-carrying heads, and these it is able to scatter on to other unwary insects that come its way.

Although there are many fungi which prey on living tissue, the main use of this division of the vegetable kingdom is to reduce complicated organic matter to simpler compounds that can be assimilated by the roots of green plants. For this purpose all soil contains vast quantities of fungoid mycelium, busily destroying what has been built up with such great care by the higher plants and animals. Were it not for these, and the smaller fungi known as bacteria, bacilli or germs, the organic matter in the soil would be useless except to a few plants, such as the bird's-nest orchis, which are also able to perform this difficult operation.

For the proper working of Nature the process of breaking down is equal in importance to the building-up process; and without the fungi this reduction would be impossible. Always we must remember that growth and decay are complementary functions. Without growth there is no decay; without decay there is no growth.

INDEX

Achene, 81.
Achillea millefolium, 207.
Adoxa moschatellina, 220.
Æthusia cynapium, 231.
Afforestation, its uses and reasons, 107.
Agave, *ill.*, 75, 155.
Ajuga reptans, 223.
Alder, catkins of, 19.
Alga, 35.
Alisma plantago-aquatica, 252.
Allium ursinum, 264.
Anagallis arvensis, 233.
Andrœcium, 79.
Anemone nemorosa, 261.
Anemone, wood, 261.
Angiosperms, 43.
Annual plants, 75.
Annual Rings, 109.
Antennaria dioica, 256.
Anther, 79.
Anthyllis vulnaria, 239.
Antirrhinum orontium, 234.
Apex, 56.
Apocarpous pistil, *ill.*, 79.
Aquilegia vulgaris, 262.
Arenaria peploides, 268.
Arrowhead, 252.
Arum maculatum, 224.
Asperula odorata, 265.
Assimilation, 66.
Australia, trees of, 65.
Awn, *ill.*, 131.

Bacteria, 36.
Bamboo, *ill.*, 135.
Barbarea vulgaris, 212.
Barberry, 212.
Bark, 109.
Barren Strawberry, 217
Bartsia odontites, 223.
Bast, 109.
Bell Heather, 258.
Bellis perennis, 202.
Berberis vulgaris, 212.
Berry, definition of, 90.
Bidens tripartita, 248.
Biennial plants, 75.
Birch, catkins of, 18.
Birdsfoot trefoil, 205.
Blackberry, 216.
Black Bryony, 224.
Blackthorn, 216.
Bladderwort, *ill.*, 178.
Bluebell, 264.
Boraginaceæ, 191.
Box, 241.
Brassica arvensis, 229.
Brazil nut, *ill.*, 151.
" Breaking of the meres ", 273.
Britain, geological structure of, 194.
Bromeliads, 170.
Brooklime, 250.
Broom, 255.
Broomrape, 173.
Bryonia dioica, 219.
Bryony, 219.
Bryony, Black, 224.
Bugle, 223.
Burnet, Great, 206.
Burnet, Salad, 240.

Butomus umbellatus, 252.
Butterbur, 248.
Butterwort, 178.
Buxus sempervirens, 241.

Cactus, 107.
Cakile maritima, 267.
Calluna vulgaris, 257.
Calystegia sepium, 222.
Calystegia soldanella, 269.
Calyx, 78.
Cambium, 109.
Campanula rotundifolia, 256.
Campion, Red, 263.
Cardamine pratense, 202.
Carpel, 43, 79.
Carrot, Wild, 206.
Caryophyllaceæ, 189.
Catkins, willow, poplar, birch, 12, 18.
Cat's Ear, 208.
Cat's Foot, 256.
Caucalis anthriscus, 220.
Cells, *ill.*, 52.
Cells, kinds of, 54.
Cells, modification of, 74.
Cells, reproductive, 75.
Cell-sap, 53.
Cellulose, composition of, 53.
Cellulose, production for commerce, 157.
Centaurea Cyanus, 232.
Centaurea nigra, 208.
Centaurium umbellatum, 271.
Centaury, 271.
Century Plant, 75.
Charlock, 229.
Chestnut, 150.
Chlorophyll, 44, 57.
Christmas Rose, 262.
Chrysanthemum leucanthemum, 208.
Chrysanthemum segetum, 232.
Cinchona, 111.
Cinnamon, 111.
Cinquefoil, 206.
Circæa Lutetiana, 263.
Clay, 118.
Cleavers, 221.
Cleistogamic Flowers, 263.
Clematis vitalba, 243.
Clinopodium vulgare, 223.
Clover, 204.
Clusia, *ill.*, 170.
Cochlearis officinalis, 270.
Cocoa, *ill.*, 95.
Coco-nut, *ill.*, 145.
Coffee, 94.
Coltsfoot, 249.
Columbine, 262.
Common Hawkweed, 256.
Compositæ, 190.
Conifers, 107.
Conifers, pollination of, 21.
Conium maculatum, 219.
Corn Buttercup, 228.
Corn Cockle, 230.
Corn Marigold, 232.
Corn Sow-thistle, 233.
Cornel, 220.
Cornflower, 232.
Cornus sanguinea, 220.
Corolla, 78.
Cortex, 109.
Cotton, *ill.*, 98.
Cotyledon, 50.
Cow Parsnip, 220.
Cowslip, 203.
Cow-wheat, 259.
Crab Apple, 218.
Crambe maritima, 267.
Crane's Bill, 204.
Cratægus oxycantha, 218.
Creeping Jenny, 249.
Creeping Willow, 260.
Crimson Heath, 258.
Crithmum maritimum, 270.
Cross-leaved Heath, 258.
Crow-foot, Upright Meadow, 204.
Cruciferæ, 188.
Cytisus scoparius, 255.

Daisy, 202.
Dandelion, 203.
Date, *ill.*, 97.
Daucus carota, 206.

Deciduous plants, transplanting of, 63.
Deciduous trees, functions of leaves of, 105.
Devil's Bit Scabious, 207.
Devil's Leaf, 161.
Dicotyledon, 51.
Digitalis purpurea, 265.
Diœcious plants, 19.
Dipsacus sylvestris, 221.
Disk florets, 202.
Divisions of Vegetable Kingdom, *ill.*, 40, 41, 43.
" Doctrine of Signatures ", 200.
Dodder, 173.
Dog Rose, 217.
Dog's Mercury, 264.
Dog Violet, 262.
Dogwood, 220.
Dropwort, 240.
Duckweed, 251.
Dyer's Weed, 238.

Earth-smoke, 229.
Easter Rose, 262.
Ecology, 197.
Elder, 220.
Embryo, 81.
Enchanter's Nightshade, 263.
Endymion non-scripta, 264.
Epigynous, 82.
Epilobium angustifolium, 248.
Epilobium hirsutum, 248.
Epiphytes, *ill.*, 168.
Erica cinerea, 258.
Erica tetralix, 258.
Eryngium maritima, 268.
Essential Oil, 111.
Euonymus Europæus, 215.
Eupatorium cannabinum, 248.
Euphorbia amygdaloides, 263.
Euphrasia nemorosa, 258.
Evergreen trees, protection of leaves of, 105.
Eyebright, 258.

Ferns, 43.
Fertilizers, 123.
Fibre, vegetable, 152.
Fibres, 54.
Fibro-vascular bundles, 55.
Fibro-vascular tissue, 54.
Field Bugloss, 234.
Field Madder, 232.
Fig, pollination of, 91; *ill.*, 92.
Filament, 79.
Fine-leaved Heath, 258.
Flax, for fibre, 152.
Flax, for oil, 144.
Flax, preparation of, 154.
Floral diagram described, *ill.*, 82.
Flower, male and female parts, *ill.*, 12, 13.
Flower, parts of, 77, 78; *ill.*, 79.
Flowering Rush, 252.
Flower-shapes, *ill.*, 83.
Fool's Parsley, 231.
Forests, destruction of, 108.
Foxglove, 265.
Fritillaria meleagris, 251.
Fritillary, Snake's Head, 251.
Frogbit, *ill.*, 250.
Fruit, kinds of, 89, *ill.*, 91.
Fruit, purpose of, 88.
Fumaria officinalis, 229.
Fumitory, 229.
Fungi, 36, *ill.*, 277.
Furze, 254.

Galeopsis tetrahit, 235.
Galium aparine, 221.
Galium saxatile, 255.
Gamopetalous, 79.
Garlic, 264.
Genus, 42.
Geographical classification of British Plants, 195.
Geological structure of Britain, 194.
Geranium pratense, 204.
Geranium Robertianum, 214.
Germination, 49.
Gipsy Wort, 250.
Glaucium flavum, 270.
Glaux maritima, 268.
Goat's Beard, 209.

Goldilocks, 262.
" Gory Dew ", 274.
Grasses, importance of, *ill.*, 127.
Grassy Stitchwort, 254.
Great Bindweed, 222.
Great Burnet, 206.
Great Chickweed, 248.
Greater Stitchwort, 213.
Green Hellebore, 262.
Ground Ivy, 223.
Ground nut, *ill.*, 147.
Growing points, 52, 56.
Gymnosperms, 43.
Gynœceum, 79.

Hardhead, 208.
Harebell, 256.
Hawkweed, 256.
Hawthorn, 218.
Hazel, pollination of, *ill.*, 16, 17.
Heath Bedstraw, 255.
Heath, Crimson, 258.
Heath, Cross-leaved, 258.
Heath, Fine-leaved, 258.
Heather, 257.
Heather, Bell, 258.
Hedera helix, 226.
Hedge Mustard, 213.
Hedge Parsley, 220.
Helianthemum chamæcistus, 239.
Hellebore, green, 262.
Helleborus viridis, 262.
Hemlock, 219.
Hemp, *ill.*, 152.
Hemp Agrimony, 248.
Hemp Nettle, 235.
Heracleum sphondylium, 220.
Herb Robert, 214.
Herminium monorchis, 243.
Hieracium vulgatum, 256.
Hippophæ rhamnoides, 269.
Hoary Ragwort, 222.
Hogweed, 220.
Honeysuckle, 225.
Hop Trefoil, 205.
Humus, 118.
Hybridizing, 86.
Hydrocharis morsus-ranæ, 250.
Hypericum perforatum, 214.
Hypochæris radicata, 208.
Hypogynous, 82.

Indian Trumpet Leaf, 183.
Inflorescence, forms of, *ill.*, 84.
Insects, protection against, 164.
Isatis tinctoria, 270.
Ivy, 226.

Jack by the Hedge, 213.
Jasione montana, 256.
Jute, 153.

Kidney Vetch, 239.
Knapweed, 208.

Labiatæ, 191.
Lady's Fingers, 239.
Lady's Smock, 202.
Lady's Tresses, 245.
Lamb's Lettuce, 232.
Lapsana communis, 222.
Latex, 164.
Lathyrus pratensis, 215.
Leaves adapted to dry climates, 64.
Leaves, folding of, 67.
Leaves, forms of, 68; *ill.*, 69, 70.
Leaves, general description, *ill.*, 61.
Leaves, growth of, *ill.*, 62.
Leaves, protective, 70.
Leguminosæ, 189.
Lemna minor, 251.
Lesser Celandine, 202.
Lichens, 275.
Lime, 118.
Limonium vulgare, 268.
Ling, 257.
Linseed, 143.
Lonicera periclymenum, 225.
Loosestrife, Purple, 248.
Loosestrife, Wood, 265.
Loosestrife, Yellow, 249.
Lords and Ladies, 224.
Lotus corniculatus, 205.
Lychnis alba, 230.
Lychnis dioica, 263.

Lychnis githago, 230.
Lycopsis arvensis, 234.
Lycopus europæus, 250.
Lysimachia nemorosa, 265.
Lysimachia nummularia, 249.
Lysimachia vulgaris, 249.
Lythrum salicaria, 248.

Mace, 101.
Maize, *ill.*, 137.
Malvaceæ, 189.
Marram grass, *ill.*, 134.
Marsh forget-me-not, 249.
Meadow Crane's Bill, 204.
Meadow Sweet, 205.
Meadow Vetchling, 215.
Medulla, 55.
Medullary rays, 56.
Melanpyrum pratense, 259.
Mentha pulegium, 259.
Mercurialis perennis, 264.
Meristematic tissue, 56.
Mignonette, cultivated, 238.
Mignonette, wild, 238.
Milfoil, 207.
Milkwort, 254.
Mistletoe, 171.
Moneywort, 249.
Monkey nut, 147.
Monkey-pot tree, 151.
Monocotyledon, 51.
Monocotyledons, 125.
Monœcious plants, 19.
Moschatel, 220.
Moulds, *ill.*, 277.
Mushroom, *ill.*, 279.
Musk Orchid, 243.
Myosotis scorpioides, 249.

Natural Order, 39.
Natural Orders, *ill.*, 185.
Nepenthes, 181.
Nepeta hederacea, 223.
Nettle, 224.
Nettle, poison of, 160.
Nightshade, Enchanter's, 263.
Nipplewort, 222.
Nitrogen, sources of, 121.
Nucleus, 53.
Nutmeg, *ill.*, 99.
Nut-oil, 150.

Oil-cake, 143.
Oil from nuts, 150.
Olive, 145.
Onobrychis viciæfolia, 239.
Opuntia, *ill.*, 160.
Orchid, musk, 243.
Orchids, 170.
Orchis mascula, 210.
Orchis pyramidalis, 245.
Ovule, fertilization of, *ill.*, 14, 23.
Ovules, 12.
Oxalis acetocella, 263.
Ox-eye Daisy, 208.

Papaveraceæ, 188.
Papaver Rhœas, 229.
Paper, made from wood, 30.
Parasites, 167.
Pedicullaris sylvatica, 259.
Pennyroyal, 259.
Pepper, *ill.*, 101.
Perennial plants, 75.
Perforate St. John's Wort, 214.
Perianth, 78.
Perigynous, 82.
Periwinkle, 225.
Phloem, 109.
Phyto-geography, 197.
Pineapple, 91.
Pistachia, 114.
Pistil, 79.
Pitcher plants, *ill.*, 181.
Pith, 55, 109.
Plant life, distribution of, *ill.*, 192.
Plantago maritima, 269.
Plants, protection of, 158.
Plumule, 50.
Poison Ivy, 161.
Pollen grain described, 80.
Pollination, 16, 20, 80.
Polygala vulgaris, 254.
Polypetalous, 79.
Poplar, catkins of, 18.
Poppy, pollination of, *ill.*, 21.

Poppy, Red, 229.
Poppy, Yellow Horned, 270.
Potentilla erecta, 255.
Potentilla reptans, 206.
Potentilla sterilio, 217.
Poterium officinale, 206.
Poterium sanguisorba, 240.
Primrose, 265.
Primula veris, 203.
Primula vulgaris, 265.
Protoplasm, the " life-substance ", 52.
Prunella vulgaris, 209.
Prunus spinosa, 216.
Purple Orchis, 210.
Pyramidal Orchis, 245.
Pyrus malus, 218.

Quinine, 111.

Radicle, 50.
Radicula amphibia, 247.
Radicula nasturtium aquaticum, 247.
Rafflesia Arnoldi, *ill.*, 173.
Ranunculaceæ, 185.
Ranunculus acris, 204.
Ranunculus arvensis, 228.
Ranunculus auricomus, 262.
Ranunculus ficaria, 202.
Rape, 144.
Rattle, Red, 259.
Rattle, Yellow, 209.
Ray florets, 202.
Receptacle, *ill.*, 82.
Red Bartsia, 223.
Red Campion, 263.
Red Poppy, 229.
Red Rattle, 259.
Reeds and rushes, 132.
Reindeer Moss, 276.
Reseda alba, 238.
Reseda lutea, 238.
Reseda odorata, 238.
Respiration, 65.
Rhinanthus crista-galli, 209.
Rhizome, *ill.*, 46.
Rhodites rosea, 218.
Rice, *ill.*, 141.
Rock Rose, 239.
Root-cap, 57.
Root pressure, 60.
Rosa canina, 217.
Rosaceæ, 190.
Rose, Christmas, 262.
Rose, Dog, 217.
Rose, Easter, 262.
Rosebay, Willow-herb, 248.
Rubber, 113, 164.
Rubus fructicosus, 216.

Sage flower, pollination of, *ill.*, 20.
Sagittaria sagittifolia, 252.
Sago, 156.
Sainfoin, 239.
Salad Burnet, 240.
Salix repens, 260.
Salsola kali, 271.
Saltwort, 271.
Sambucus nigra, 220.
Samphire, 270.
Sand, 118.
Sanicle, 264.
Sanicle europæa, 264.
Sarracenia, 181.
Sauce alone, 213.
Scabiosa succisa, 207.
Scabious, Devil's Bit, 207.
Scabious, Sheep's Bit, 256.
Scandens pecten veneris, 231.
Scarlet Pimpernel, 233.
Scilla nutans, 264.
Scorpioid cyme, 250.
Scorpion Grass, 249.
Scrophularia aquatica, 250.
Scrophulariaceæ, 191.
Scurvy Grass, 270.
Scutellaria galericulata, 250.
Sea Buckthorn, 269.
Sea Campion, 267.
Sea Holly, 268.
Sea Kale, 267.
Sea Lavender, 268.
Sea Milkwort, 268.
Sea Plantain, 269.
Sea Purslane, 268.

Sea Rocket, 267.
Seaside Bindweed, 269.
Seed, distribution of, *ill.*, 89.
Seed of Scarlet runner, *ill.*, 49, 50.
Seeds, formation of, 87.
Self-heal, 209.
Semi-parasites, 172.
Senecio crucifolius, 222.
Sensitive Plant, *ill.*, 162.
Sheep's Bit Scabious, 256.
Shepherd's Needle, 231.
Sherardia arvensis, 232.
Sieve tube, *ill.*, 54.
Silene maritima, 267.
Sisal, *ill.*, 155.
Sisymbrium alliara, 213.
Sisymbrium officinale, 213.
Skull Cap, 250.
Sloe, 216.
Small Snapdragon, 234.
Snake's Head Fritillary, 251.
Soil, importance of, 115.
Soil, ingredients of, 116.
Soil, making of, 89, 194.
Sonchus arvensis, 233.
Soya bean, 148.
Speedwell, Common, 235.
Speedwell, Germander, 235.
Speedwell, Ivy-leaved, 234.
Spergula arvensis, 230.
Spergularia rubra, 231.
Spergularia sativa, 231.
Spermaphyta, 43.
Spices, 99.
Spindlewood, 215.
Spines, 159.
Spiræa filipendula, 240.
Spiræa ulmaria, 205.
Spiranthes autumnalis, 245.
Spore, 43.
Spurrey, common, 231.
Spurrey, Corn, 230.
Spurrey, Sand, 231.
Stamen, 79.
Star-slime, 274.
Statice maritima, 271.
Stellaria aquatica, 248.
Stellaria graminea, 254.
Stellaria holostea, 213.
Stigma, 79.
Stomata, 62.
Strawberry, Barren, 217.
Strawberry, wild, 217.
Style, 79.
Substances necessary for plant growth, 123.
Sugar-cane, *ill.*, 140.
Sundew, *ill.*, 175.
Syncarpous pistil, *ill.*, 79.

Tamarisk, 269.
Tamarix gallica, 269.
Tamus communis, 224.
Tanacetum vulgare, 227.
Tansy, 227.
Taraxacum officinale, 203.
Taxus baccata, 242.
Tea, 71.
Teasel, 221.
Telegraph Plant, 162.
Thallus, 43.
Thorns, 158.
Three-lobed Butterbur, 248.
Thrift, 271.
Thymus serpyllum, 241.
Tobacco, 72.
Toothwort, 173, 180.
Topiary work, 242.
Toranthus, 172, 174.
Tormentil, 255.
Transpiration, function described, 58.
Tragopogon pratense, 209.
Traveller's Joy, 243.
Trees as landmarks, 104, 105.
Trees, structure of, 109.
Trifolium, 204.
Trifolium procumbens, 205.
Tufted Vetch, 215.
Turpentine, 113.
Tussilago farfara, 249.

Ulex Europæus, 254.
Umbelliferæ, 190.
" Unintentional Distribution ', 92.
Uni-sexual flowers, 86.

Upright Meadow Crowfoot, 204.
Urtica dioica, 224.

Vaccinium myrtillus, 257.
Valerian, 245.
Valeriana officinalis, 245.
Valerianella olitoria, 232.
Vanilla, *ill.*, 102.
Vascular spaces, 53.
Venus's Comb, 231.
Venus's Fly-trap, 176.
Veronica Beccabunga, 250.
Veronica chamædrys, 235.
Veronica hederæfolia, 234.
Veronica officinalis, 235.
Viburnum lantana, 243.
Vicia cracca, 215.
Vinca minor, 225.
Viola, 262.
Violet, 262.
Violet, Dog, 262.
Violet, Wood, 262.

Walnut, *ill.*, 150.
Water Figwort, 250.
Water necessary to plant life, 59.
Water plantain, 252.
Water-cress, 247.
Water-cress, Giant Yellow, 247.
Wayfaring Tree, *ill.*, 243.
Wheat, 135.
White Campion, 230.
Whortleberry, 257.
Wild Carrot, 206.
Wild Thyme, 241.
Willow, catkins of, 18.
Willow, Creeping, 260.
Willow-herb, Great Hairy, 248.
Willow-herb, Hairy, 248.
Willow-herb, Rosebay, 248.
Winter Cress, 212.
Woad, 270.
Wood Anemone, 261.
Wood Basil, 223.
Wood Loosestrife, 265.
Wood Sorrel, 263.
Wood Spurge, 263.
Wood Violet, 262.
Wood, world-wide use of, 30.
Woodruff, 265.

Xylem, 109.

Yarrow, 207.
Yellow Horned Poppy, 270.
Yellow Loosestrife, 249.
Yellow Rattle, 209.
Yew, 242.

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